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JUNE 1958

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HUGO GERNSBACK, Editor

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(See page 28)

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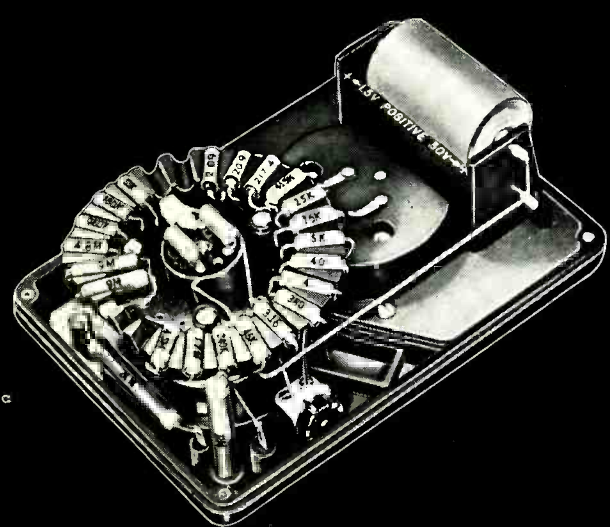

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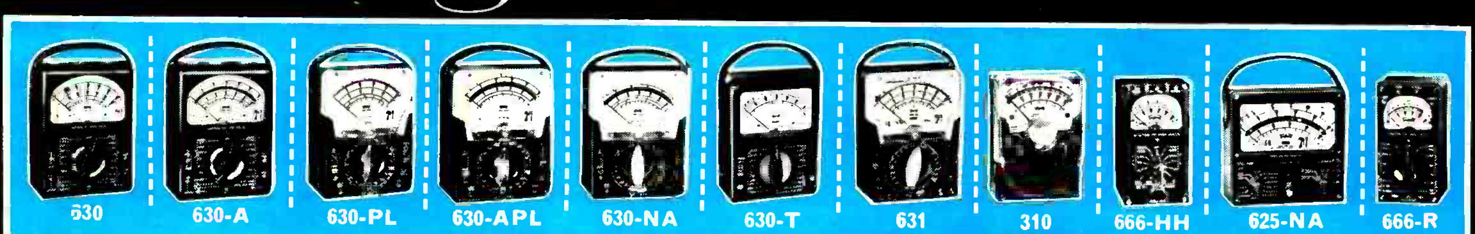

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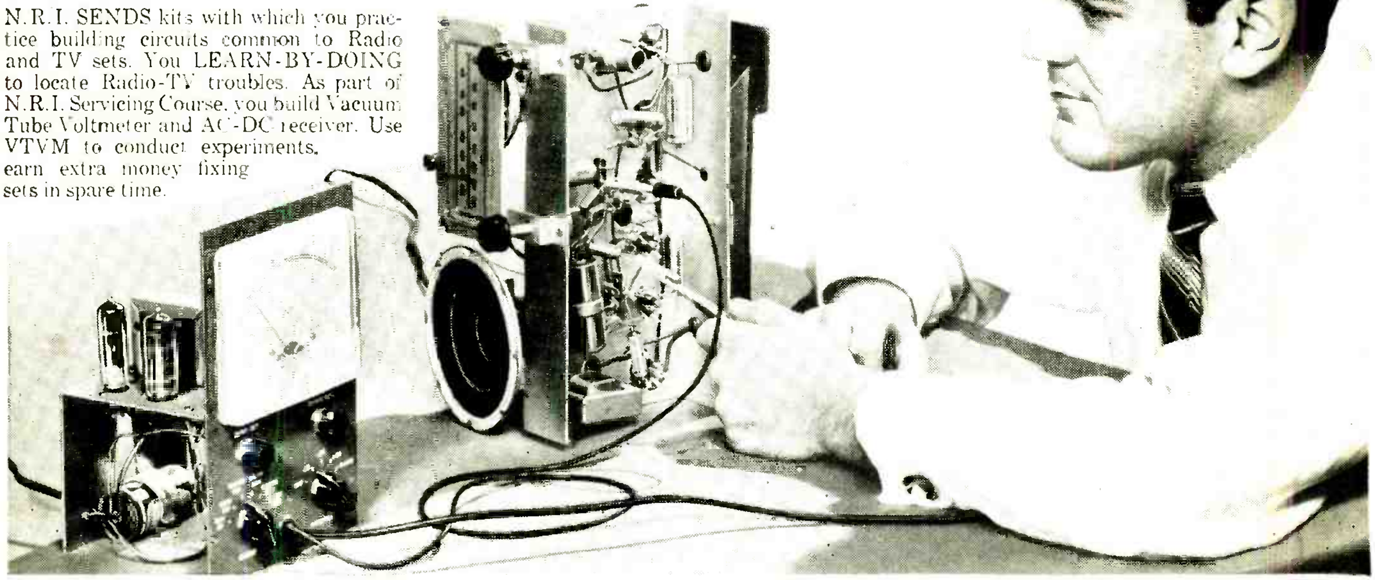

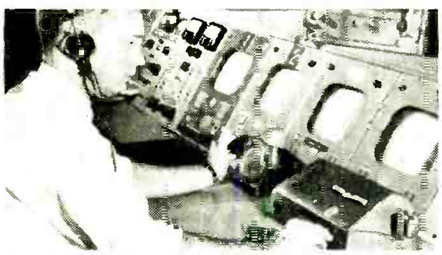

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ON THE COVER

(Story on page 28)

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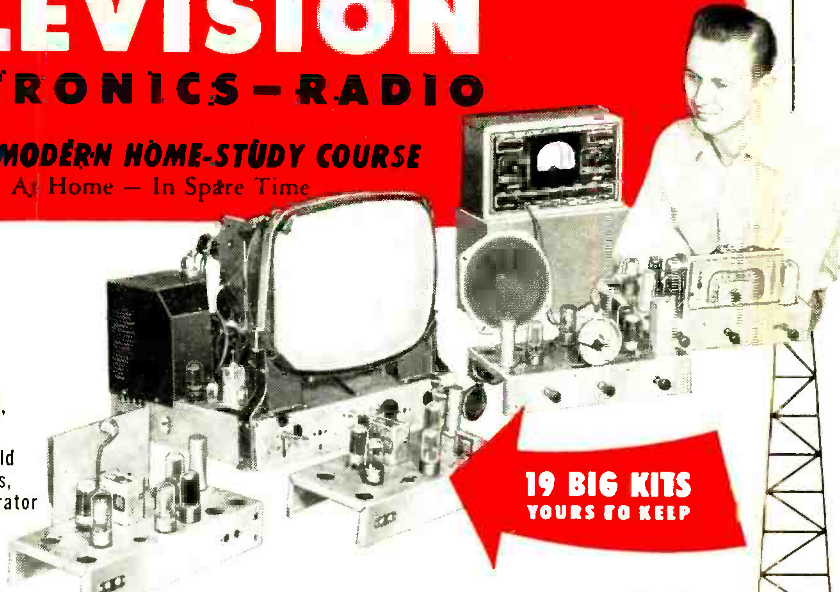

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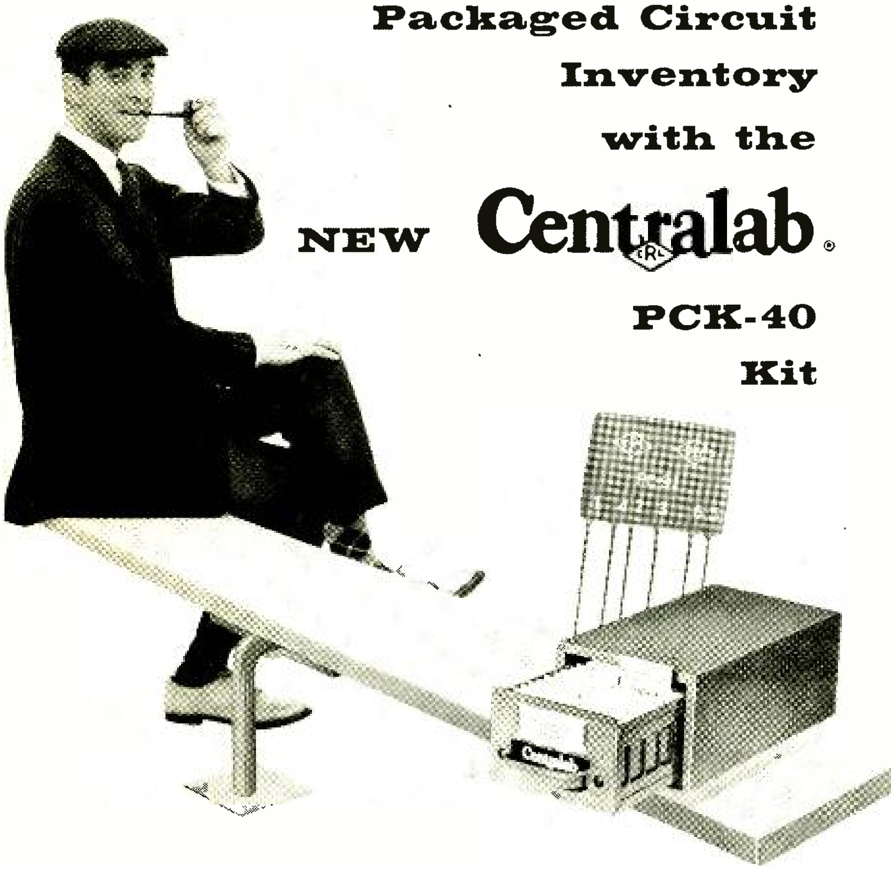

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News Briefs

SEMICONDUCTORS MOVE into the regulation field with the announcement of a field-effect varistor developed by R. M. Warner, Jr., H. A. Stone and E. I. Douchette of Bell Telephone Laboratories. The unit has a constant-current feature which makes it ideal as a current regulator. It can also be used as a current limiter or pulse shaper and its high ac impedance makes it useful as a coupling choke or ac switch.

The device has a single diffused junction (see Fig. 1). Current passes parallel to this junction through a constricted area called the "channel."

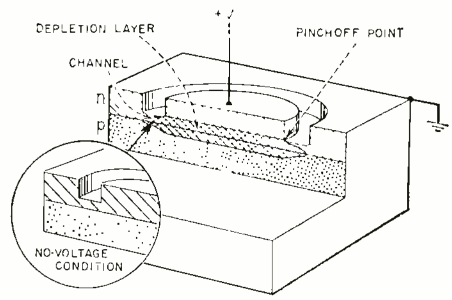

FIG.1

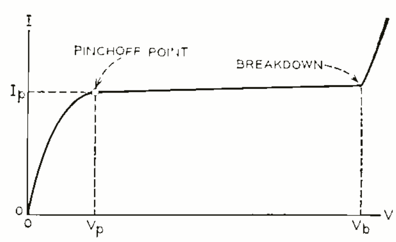

FIG 2

As the voltage across the device is increased, current increases and a depletion area builds up which eventually reaches through the entire thickness of the channel. At this point, called the "pinchoff" point, a further increase in voltage does not increase current. As voltage is raised still higher, a breakdown point is reached, and current increases again. But between the pinchoff and breakdown points the current is essentially constant and this is the area used (see current curve in Fig. 2).

MASER AMPLIFIER BRINGS VENUS and other astronomical targets 10 times closer than previously possible, when coupled to a radio telescope. Now in use, the unit has been installed as part of the 50-foot radio telescope at the Naval Research Laboratory in Washington. The MASER (*M*icrowave *A*mplification by *S*timulated *E*mission of *R*adiation, see RADIO-ELECTRONICS, June, 1955) device operates on a 3-cm wavelength and was developed as a

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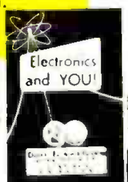

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joint project of Columbia University and the Naval Research Lab.

It is a solid-state device that uses a synthetic ruby as the Maser amplifier. Freedom from electrical noise inherent in other types of amplifiers enables Maser devices to amplify signals much too weak to be handled by conventional amplifiers.

A similar device is slated for operation with Harvard University's radio telescope. Here, a potassium cobalticyanide crystal will be used with a 21-cm wavelength.

AN ELECTRONIC COMPUTER using punched cards and magnetic tape was used to index the Dead Sea scrolls, ancient Hebrew writings discovered in 1947 in a cave in Jordan, near the west coast of the Dead Sea. This system has saved many hours of tedious labor formerly done by hand. Each word was placed on a punch card. The information cards were then converted to tape by the machine. The 29,250 words took about 2 hours and 2 reels of tape. The final step turned out a printed alphabetical summary list in Hebrew at 150 lines a minute. The computer that did the job is the IBM 705 data-processing machine.

Calendar of Events

Armed Forces Communications and Electronics Association's Show, June 4–6, Sheraton Park Hotel, Washington, D. C.
National Symposium on Production Techniques, June 5–6, Hotel New Yorker, New York, N. Y.
Southwest High Fidelity Show, June 6–8, Shamrock Hilton Hotel, Houston, Tex.
National Convention on Military Electronics, June 16–18, Sheraton Park Hotel, Washington, D. C.
French Electronic Components Show, June 20–26, 23 Rue de Lubeck, Paris.

3,000 MILE RADIO NETWORK, using tropospheric forward scatter propagation (see RADIO-ELECTRONICS, October 1957, page 6; September 1956, page 37 and August 1955, page 39), has gone into operation in Alaska. The network, project White Alice, links the radar warning outposts of the Alaskan Air Command with the Alaskan portion of the DEW (*D*istant *E*arly *W*arning) line spread across Alaska and Canada.

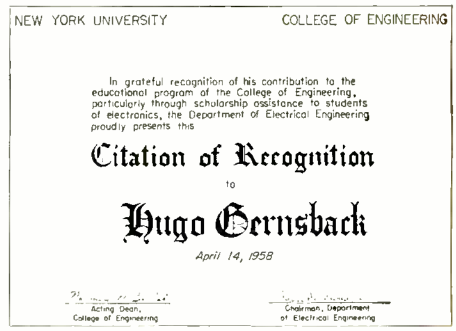
The system has been under construction since 1955. It was built by Western Electric and is operated by civilian employees of the Federal Electric Co.

INTEGRATED RADIO SYSTEM for San Francisco police, fire, civil defense and other local agencies brings the city's radio communications up to date. Under the new system, the Police Department will operate on four frequencies in the 40–50-mc band. A fifth frequency, in the 150-mc band, has been set aside for the use of affiliated law enforcement agencies.

Thoroughly covering the city, 17 base stations, including 10 located at police precincts, serve 185 cars and 164 motorcycles equipped with dual-channel equipment.

The earlier net, which operated on 2466 kc, will be assigned to the telephone company for ship-to-shore use.

CITATION OF RECOGNITION for his contribution to the educational program of the College of Engineering has been awarded Hugo Gernsback by New York University. Among his efforts is Mr. Gernsback's annual award, through NYU's Electrical Engineering Department, of a $1,000 scholarship to an outstanding student.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In grateful recognition of his contribution to the educational program of the College of Engineering, particularly through scholarship assistance to students of electronics, the Department of Electrical Engineering proudly presents this

Citation of Recognition

to

Hugo Gernsback

April 14, 1958

Acting Dean, College of Engineering — Chairman, Department of Electrical Engineering

HAVE YOU SEEN COLOR TV? RCA estimates that 75% of all Americans haven't. Of those who have color TV receivers, 91% are said to report complete satisfaction. And 80% of owners recommend buying a color receiver to their friends and two out of every three customers say they are buying a color receiver because of their friends' recommendations.

MEDICAL ELECTRONICS CONFERENCE, sponsored by the Council of International Organizations of the Medical Sciences (CIOMS), has been formed with the backing of UNESCO and the World Health Organization. The Medical Electronics Center of the Rockefeller Institute under the direction of Dr. V. K. Zworykin has undertaken the task of organizing the conference on an international scale.

The full-scale conference is tentatively scheduled for the spring of 1959. A preliminary meeting, to appoint the Conference Committee, will be held June 26, 27, 28, 1958, at the Grand Amphithéâtre, Commun de la Nouvelle Faculté de Médicine, Paris, France.

STEREO MUSIC from another station, WNBF in Binghamton, N. Y., is now on the air. The station transmits stereo tapes, using its AM and FM outlets. Listeners obtain the stereo effect by proper placement of their radio receivers. At present a 1-hour program is aired each week.

MAGNETIC FIELDS to keep missiles and spaceships cool when they hit the atmosphere has been proposed by Dr. Joseph L. Neuringer of Republic Aviation. It is a system of magnetohydrodynamic (or hydromagnetic) insulation.

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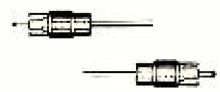

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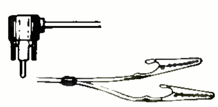

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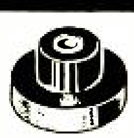

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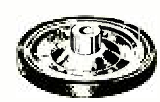

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About 2% of the air's atoms are ionized at this temperature. This mixture, called a plasma, is a conductor of electricity.

When an electrical conductor is pushed across a magnetic field, current flows through it and it is slowed down.

The idea behind the new system is to form a strong magnetic field on the front surface of the spaceship or missile. With ionized air flowing across it, the breaking action of the field will cause the air to pile up in a deeper, slower-moving layer and it will not transfer as much heat to the object's surface.

According to Neuringer, a magnetic field of about 3,000 gauss should reduce heat transfer 28%. A further reduction might be obtained by coating the nose of the object with a material that ionizes easily. Its ions mixed with those of the air would make a stronger conducting plasma that would be more effectively slowed by magnetism.

TWO NEW TV STATIONS started programming since we last reported:

KVIQ, Eureka, Calif. 6
KGHL-TV, Billings, Mont. 8

The following new call letters were chosen:

KMSP, Minneapolis–St. Paul, Minn. 9
(formerly KMGM-TV)
KMOX-TV, St. Louis, Mo. 4
(formerly KWK-TV)
WNTA-TV, Newark, N. J. 13
(formerly WATV)

US operating stations now total 541 (446 vhf and 95 uhf), 31 of which are noncommercial.

Havana, Cuba, has opened its sixth outlet on a 14-hour (6:00 A.M. to 2:00 A.M.) daily all-color schedule from the Havana-Hilton Hotel. Its name is simply Canal 12.

CUTS IN TAXES AND IMPORTS are the aims the Electronics Industries Association (EIA) came up with at their recent Spring Industry Conference. Specific points the EIA wants are: lower excise taxes on radio and TV receivers and phonographs—5% instead of the current 10%; curbs on rising imports of Japanese-made components and radios, and steps toward going into the testing business by taking over the operation of a tube-testing laboratory formerly run by RCA.

A TRANSISTOR BURGLAR ALARM which uses an infra-red beam modulated at 55 cycles as its light source and a synchronous phase-sensitive demodulator pickup is now available. The all-transistor device, developed at Walter Kidde & Co., uses a different frequency than the standard 60-cycle line source to prevent intruders from using another light to keep the alarm from going off. Interruption of the 55-cycle beam or a change in its frequency keys the alarm.

The unit uses a transistor amplifier and oscillator, and a phototransistor to detect the light. A reference signal is compared with the 55-cycle light. Any variation sets off the alarm. END

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Radio Operator

Capital Airlines (Ohio) is looking for a radio operator. A touch typing speed of 40 wpm is necessary. Must have at least a restricted operator's permit, but a radio-telephone 2nd or 1st class license is desirable.

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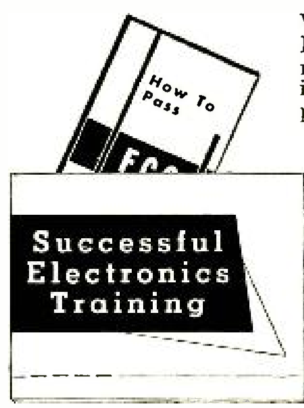

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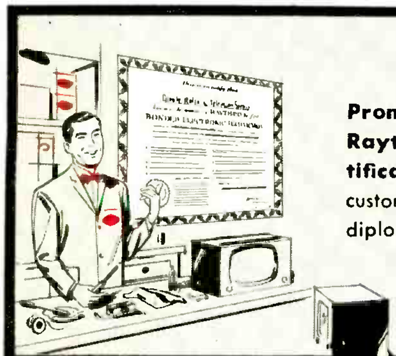

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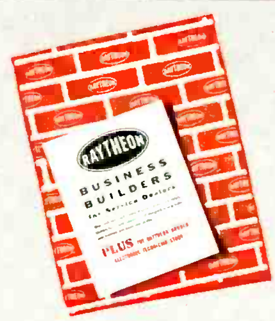

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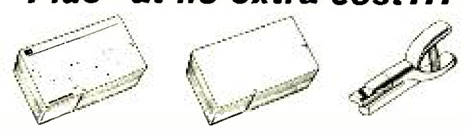

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Correspondence

STANDS BEHIND THE OTL

Dear Editor:

As a proponent of the OTL (output transformer*less*) power amplifier I must take exception to some of the statements made by Herbert Ravenswood in his article "Is the Output Transformer Out" which appeared in the January, 1958, issue. It is evident that he is biased (way down to class C) against the OTL amplifier. The single-ended push-pull output stage has made the OTL power amplifier practical. To say that this configuration produces more distortion than the usual form of push-pull stage is not true. Provided the output tubes are matched and driven symmetrically, then they are both equally capable of low-distortion operation. This is so with triodes or pentodes, under class-A, -AB and -B, conditions.

Mr. Ravenswood also states that the single-ended push-pull output stage requires very unequal drive for its operation and this also is not true. As shown in Fig. 1 of the Peterson-Sinclair article, cited by Mr. Ravenswood, a push-pull driver transformer providing equal signal voltages, 180° out of phase, is used to drive each output tube; exactly as in the customary push-pull output stage. However, modern feedback amplifier design cannot tolerate a driver transformer and in the usual push-pull circuit it has been eliminated by various types of phase-inverter and phase-splitter circuits. These are well known in the art.

The single-ended push-pull output stage, however, when used with these circuits does not operate in true push-pull; hence the increased distortion cited by Mr. Ravenswood. Two circuit configurations have been developed that do operate the single-ended push-pull output stage in true push-pull under any and all conditions. These are the Peterson-Sinclair and the Futterman circuits.

Mr. Ravenswood is not impressed with the idea of eliminating the output transformer. Let me list briefly some of the advantages gained:

1. Elimination of notch distortion: This form of distortion shows up as a ragged treble response, usually blamed on the tweeter, and will occur, even with triodes when operated under class-AB or -B conditions.

2. More negative feedback can be used: With 40 db and more of negative feedback, entirely practical with the OTL power amplifier, distortion in the

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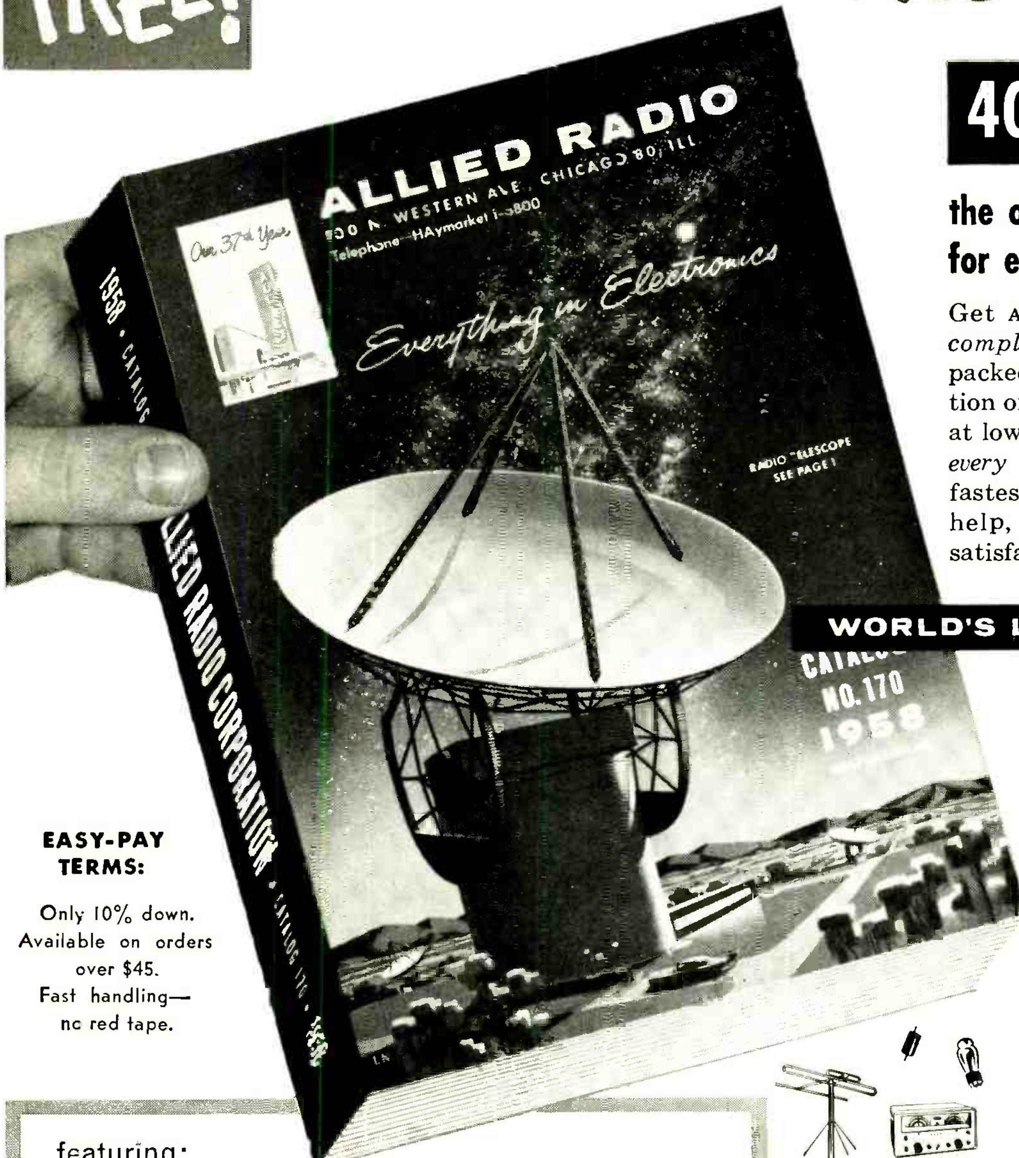

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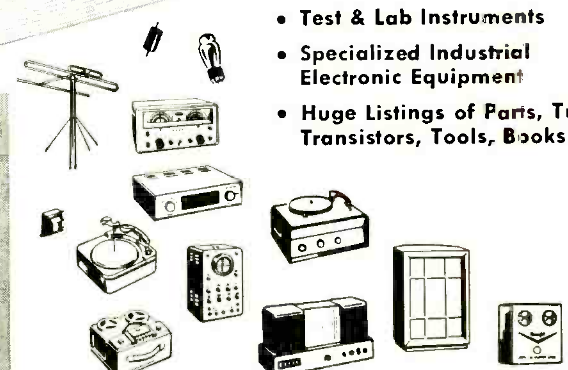

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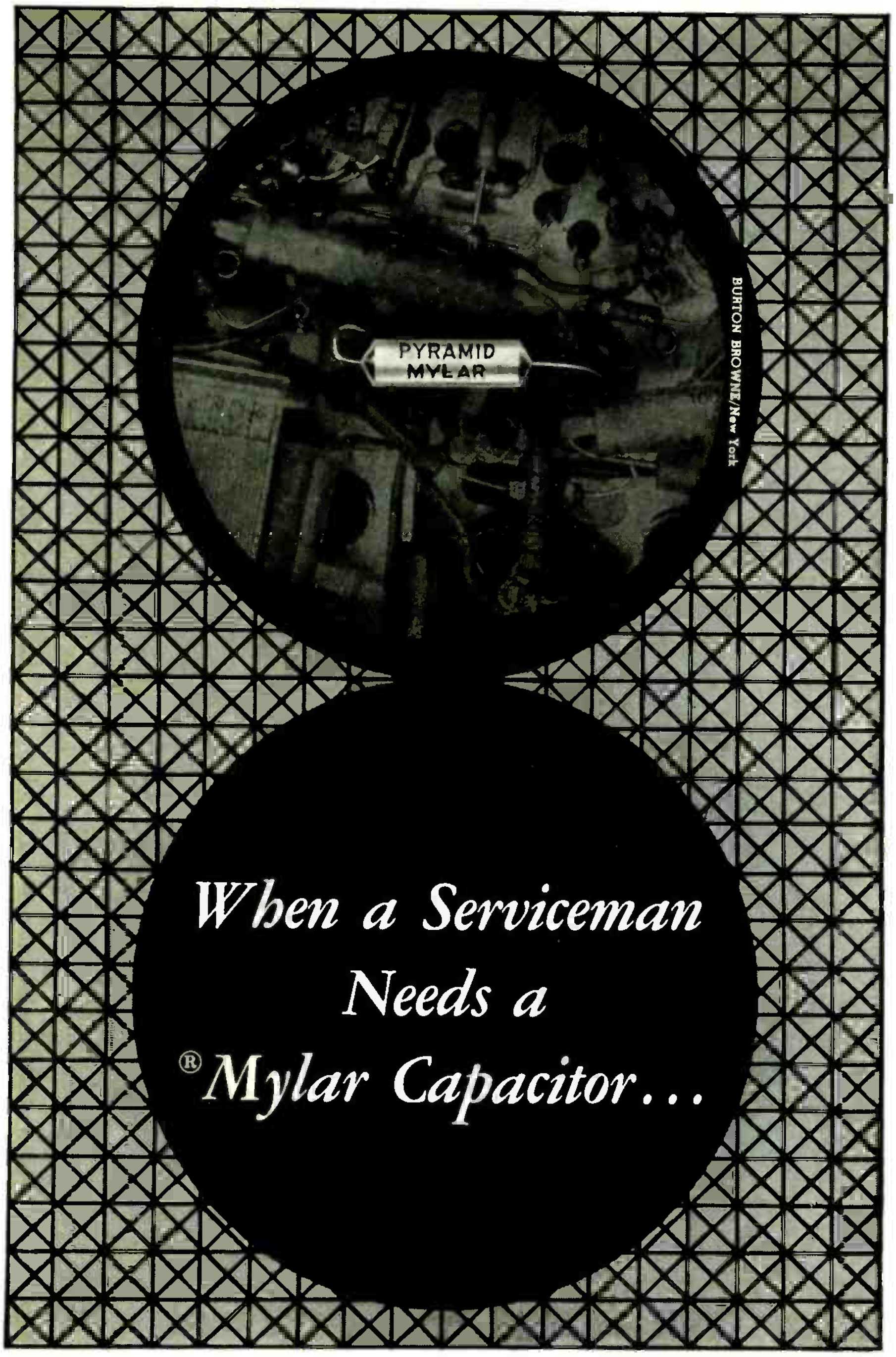

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3. Better transient response: Large amounts of negative feedback, besides reducing all forms of distortion to negligible values, also greatly improves the transient response of the amplifier. This can be heard.

In conclusion I might add that I have designed and constructed OTL power amplifiers and they have been reproduced without difficulty or trouble by scores of amateurs. What is really needed in OTL amplifier design is an output tube made specifically for this.

New York, N. Y. JULIUS FUTTERMAN

MR. RAVENSWOOD REPLIES

Dear Editor:

Mr. Futterman's letter, together with two received from different departments of the Philips' organization, reminds me of a reported conversation about the relative qualities of various social groups. Commented one, "There are good and bad among all of them." "He's prejudiced," said another, who was strongly imbued with the supposed superiority of his own group.

That I am not prejudiced against OTL amplifiers on principle, note my comments in the last paragraph of the article ("Is the Output Transformer Out," RADIO-ELECTRONICS, January, 1958): transistors do promise to make the OTL amplifier really practical. Mr. Futterman himself states that an output tube specially designed for it is really needed. So why do we not have such a tube type? Surely because the natural impedance ranges of tubes and dynamic loudspeakers differ so widely as to make it impractical.

The most logical impedance-matching device is the transformer. It does this job with less inherent distortion than a tube, and can be designed to avoid the deficiencies of its early prototypes. The cost aspect is answered by the recent twin-coupled design ("High Fidelity at Low Cost With Twin-Coupled Amplifier," RADIO-ELECTRONICS, November, 1957), to which I called attention in my penultimate paragraph. This design also solves the "impossible" situation relative to including the output transformer in the feedback loop.

To answer Mr. Futterman's points:

1. *Notch distortion: (a)* I acknowledge that notch distortion can occur with triodes—what I pointed out is that it is less likely; *(b)* it can also be eliminated using both pentodes and output transformers; vide McIntosh and twin-coupled.

2. *Feedback:* Mr. Futterman and the Philip's people apparently subscribe to the "more feedback the better" school. Demonstrations have repeatedly shown by subjective listening tests, that well-designed nonfeedback amplifiers, or ones with little feedback, are credited with giving "cleaner" reproduction than types using fabulously large amounts to achieve such wonderful specifications —(0.1% or better).

(Continued on Page 20)

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Larry Pacifico, 65 Main St., Roseto, Pa.	1st	12
Tooru Iwahashi, Honohina, Hakalua, Hawaii	2nd	8
Basil D'Imperio, 2223 H St., NW, Washington, D.C.	1st	12
John Ward, 407 E. Cowden Ave., Midland, Texas	1st	10
Herbert Halbig, 315 Park St., Tupper Lake, N.Y.	1st	11
Vregh Godoshian, 312 E. Wilson St., Pontiac, Mich.	1st	11
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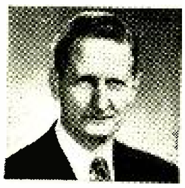

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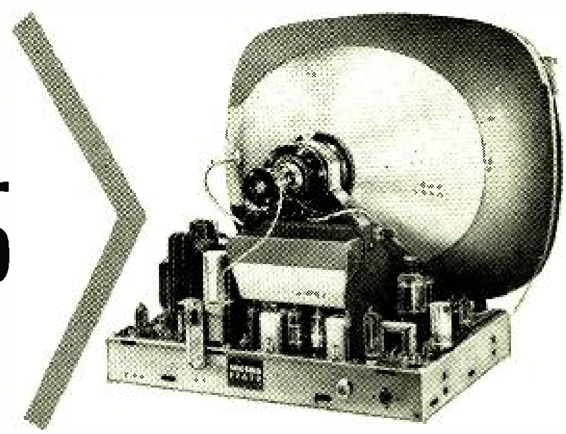

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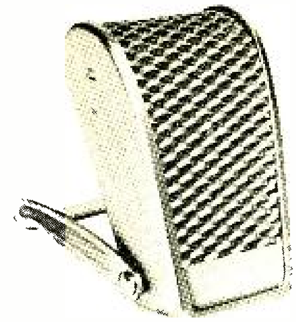

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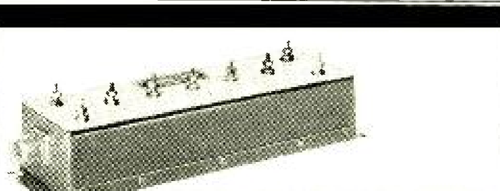

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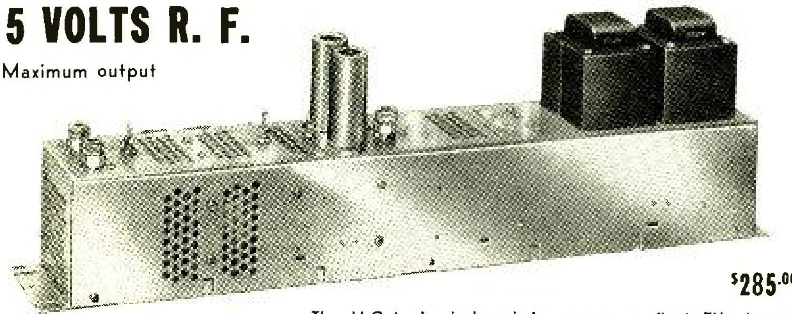
5 VOLTS R. F.

Maximum output



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- 20 db gain minimum
- 6 mc/s bandwidth
- Silicon Rectifier
- Drives a low band signal thru 2½ mi. of K-14 type cable

The H.C.A. is designed for use as a final TV channel amplifier and provides the highest output of any known model on the market today. A commercial transmitting tube (6252) is used to deliver the full-rated output without distortion.

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3. *Transient performance:* Mr. Futterman's statement here requires qualification. Large amounts of feedback do serve to reduce transient distortion, but only one form of it. Often other forms are introduced by it. Although the latter forms may not be shown by standard measurement techniques, they can be very audible.

I would like to pass on a correction to Fig. 5 of my article, as noticed by Philips. The plate-coupling resistor for the ECC83 comes from the screen of the upper UL84, not the B-plus line, as shown. While this arrangement does give theoretical true phase inversion, similar to the Peterson-Sinclair circuit of Fig. 6, my basic point stands:

The audio voltage to *ground*, which is responsible for any stray electrical coupling that may occur, is still much greater from the plate than the cathode of the ECC83, and the circuit is of quite high impedance to make it susceptible to such transfer. This comes back to Mr. Futterman's point about tubes. Transistors provide us with much lower impedance circuits and make OTL design much more practical.

HERBERT RAVENSWOOD
New York, N. Y.

WHAT'S IT ALL ABOUT?

Dear Editor:

With reference to the discussion on Doppler effects by Messrs. Klipsch, Janszen, et al, it is puzzling to me, having listened with innocent pleasure to reproduced organ music on my Ultra-Linear and other devices for, lo, these many, to learn that the literature rates this effect at the same time as being both imperceptible and intolerable.

With a sincere desire to confuse the issue further, I (no electronics pundit) wonder if anybody has considered the relation between FM effects in reproduced music and possibly similar effects occurring in sound; for example, from an actual organ. In such a case, doesn't the varying velocity of the air in wave movements at, say, 60 cycles, carry with it, as wavelets on a tide, a complex, shifting pattern of frequencies as it strikes the ear? If so, who has complained? And if these FM effects are perceptible, or intolerable, is it not possible to determine the ratio of the effects in the reproduced music to those in the original? Or the ratio between mikeside and the middle of the hall?

How does all the above appear compared to an analysis of the wild and wonderful sound of a pipe organ in a cathedral with uncontrolled acoustics? The instruments of music are allowed to retain their ancient peculiarities; the air will not be denied its eccentricities as a conveyor of sound; the human ear is variable between individuals, times and places. Must the mind, itself fallible in its judgments, now be driven mad by an endless consideration of whether a thing is perceptible or not?

ARTHUR QUALEY
La Puente, Calif.

END

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RADIO SIGNALS TO VENUS

. . . Radio to the Planets Is Now Assured . . .

THE idea of bouncing radio signals from heavenly bodies is not new. It originated with the writer in an article entitled "Can We Radio the Planets?" in the February, 1927, issue of *Radio News*. It was then proposed to send a radio signal from the earth to the moon and back via short waves. The calculated elapsed time of the signal transit was 2.5 seconds to cover the two-way distance—twice 238,854 miles, or 477,708 miles, to and from the moon. Nineteen years later, on Jan. 10, 1946, Lt. Col. John H. DeWitt and associated scientists of the US Signal Corps first established actual radio contact with the moon. The elapsed time was 2.4 seconds. Our original predicted time was 2.5 seconds, an error of 0.1 second. In the article mentioned, we also spoke of signaling Mars and Venus, but refrained from giving elapsed signal time, because of the extreme complexity of the problem. In 1927, we had little practical knowledge of the penetration of short waves beyond the earth's atmosphere and into space, as well as eventual reflection of the returning high-frequency waves on the Heaviside layer.

It is gratifying to note that in the fall of 1959 man will at last attempt to signal the planets—Venus and Mars, not as a stunt but for serious astronomic and scientific purposes. British radio astronomers, using the world's largest radio telescope at the Jodrell Bank radio observatory, intend to radio-contact Venus first. The scientists state that they will have a power output 3,000 times greater than the average military or airfield radar installation! Many new and important facts will be learned from such a series of experiments in bouncing signals off Venus. One will be the rotation of Venus on its axis, not known now. Our closest sister planet is constantly shrouded in dense clouds. Hence man has so far not seen the surface of Venus. Its rotation period is thought to be 20 to 30 days—a guess at best. Radio astronomy via reflected signals may give us a clue to Venus' exact time of rotation.

Let us now consider how the scientists will "shoot" Venus at its inferior conjunction in the fall of 1959, when Venus will approach within 30,000,000 miles of the earth. (The closest approach was 26 million miles on Jan. 28, 1958.) At the speed of 186,000 miles a second, the radio signal will take 5.36 *minutes* to cover the distance out and back between the two planets (2.68 minutes to go to Venus, 2.68 minutes to return).

The inherent difficulty with the present-day state of the art of radio is our inability to concentrate a beam of radio-frequency signals—the diffusion is too great. The same is true of light. With the tre-...dous distances with which we have to work, the ... spreads. It is as if we aimed a high-pressure ...m of water at a distant large football. Most ... water will not hit the object. A large part of ...hich hits will splash and reflect at different ...s and only a comparatively minute amount will ...e back in the direction of the nozzle.

It is for this reason that the British scientists must use a large power output if they hope to get back an intelligible radio echo signal from Venus.

The Jodrell Observatory radio telescope, the largest known in the world today, has a great advantage in making these experiments. On account of its large size, it can concentrate the transmitter power output into a narrower beam and, again due to its large size, it concentrates the weak echo of the returned signal more effectively.

If in the future it should become possible to concentrate and narrow the radio beam further, much less power would be required to contact the various planets. Obviously, the greater the distance between earth and the outlying planets, the more difficult the problem of bouncing back signals.

It can be seen from the above that as earth and Venus pull apart, the distance between them increases rapidly, until at maximum separation—at superior conjunction—the distance is 161 million miles. Here it would take the round-trip signal 28.8 minutes to bridge the space. But now the sun would become an obstacle, partly blocking the path of the signal.

Would the signal be absorbed by the sun? Yes. Another interesting and perhaps far-reaching test would be the effect of the sun's gravitational attraction on the returning radio echo. This is known as the Einstein shift. If, before or after superior conjunction of Venus, we send a signal to Venus in such a manner that the return signal comes close to the sun, the signal should be bent toward the sun. The Einstein shift has been confirmed with light rays, but not with radio waves up to now. This, however, at the present time can only remain a theoretical consideration. The experiment could not possibly be conducted with present radio frequencies unless we had a radio-astronomical bowl transmitting and receiving antenna *at least 60 miles in diameter!*

In the future when we can produce super high frequencies of the electronoptical variety, which approach the frequency of light, it will be possible to record the Einstein shift electronically.

There will not be very much practical difference when we try to signal Mars, because the distances between our two planets are not too great at nearest approach—about 35 million miles for Mars, 26 million for Venus. We can therefore look forward to an early radio contact with Mars, too.

What about the further outlying planets? Possible, but increasingly difficult the further out we go. To bounce a radio signal off Jupiter will take 1 hour and 10 minutes for the two-way transit; 2 hours, 22 seconds for Saturn; 12 hours, 50 minutes for Pluto! To hit *squarely* such a distant planet, say Neptune, 2,677 million miles away at its closest, is in itself a difficult feat; for the signal to return to earth *without missing it altogether* would be an achievement of a high order—at least at the present state of the art. —*H.G.*

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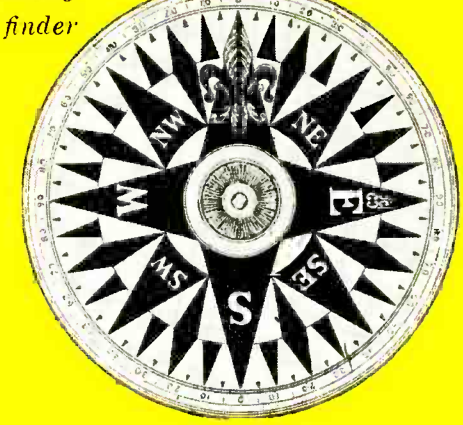
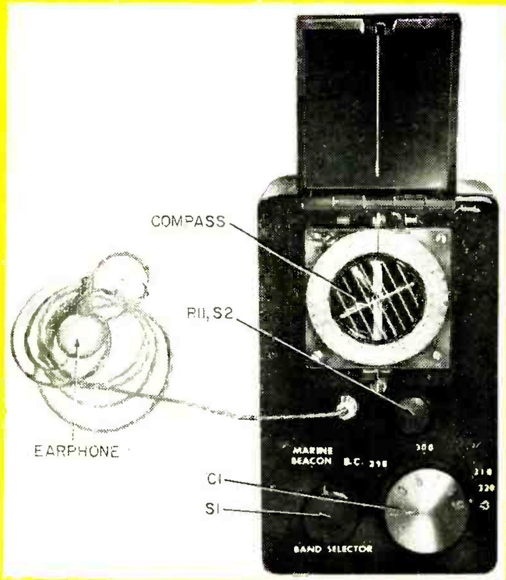
Combining a 2-band transistor superhet radio and a marching compass gives you a compact, accurate, portable direction finder

ELECTRONIC COMPASS

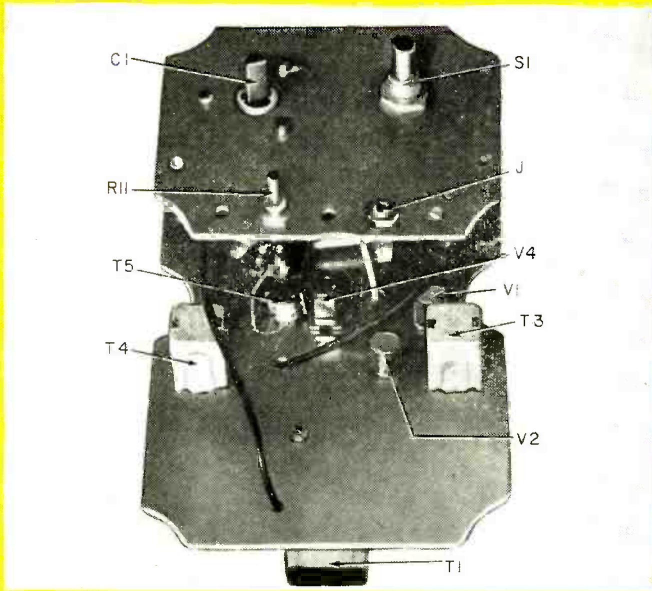
TO GUIDE YOU HOME



By J. E. PUGH, JR.



Completed unit is small enough to slip into coat pocket.



Top view of the inside chassis assembly.

An electronic compass is a worthwhile investment for people interested in outdoor activities such as motorboating, sailing, hunting, trapping, berry picking, camping, hiking or other activity where there is a possibility of getting lost.

The instrument described here was designed especially for uses where portability and ruggedness are important. It is housed in a strong Bakelite case that is easily waterproofed. It is small, lightweight, sensitive; has a sharp null point and incorporates a built-in magnetic compass. This combination of directional receiver and built-in compass is a true electronic compass and not just a radio homing device. It makes a rapid and accurate determination of actual position possible.

The superhet receiver

The receiver is a direction-sensitive superheterodyne using a class-B detector and a single audio stage. Two tuning ranges are used: the broadcast band (550 to 1,600 kc) and the marine radio-beacon band (285 to 325 kc). The broadcast band is used so bearings can be taken from nearly any location and to provide entertainment while outdoors.

The radio-beacon band provides an extra degree of usefulness to boat owners. It is a desirable feature because many rivers, canals and harbors have radio beacons located near their entrances. Broadcast stations ordinarily will not permit such close work since they are seldom found in such a desirable location. If the electronic compass is used only for nonboating activities, the marine radio-beacon band can be eliminated.

A compact, flat ferrite loop antenna provides the directional properties needed for taking bearings on radio stations. It is mounted parallel to the length of the case to obtain the null point when the long axis of the receiver is in line with the station. The antenna has a high Q (about 450 to 790 kc) for maximum selectivity and sensitivity. A matching two-gang tuning capacitor tunes the antenna and local oscillator coil over the band.

The broadcast band is tuned with the BAND SELECTOR (S1) in position BC. When the switch is thrown to MARINE BEACON, capacitor C4 is shunted across C1-a, C2 and T1 to drop the resonance range of this circuit to the radio-beacon band and at the same time restrict the tuning range so it fits this narrower band. Similarly C6 is shunted across C1-b, C3 and T2. And C5 is switched into the circuit to permit more accurate tracking of the oscillator circuit.

Although its value is not critical, C7 may have to be changed to a slightly different value in some instances. It must be large enough so the local oscillator functions properly at the lowest frequency in the marine band, but at the same time it must not be so large that feedback is excessive at the highest broadcast frequency. Too much feedback causes the oscillator to generate harmonics and reception of signals above the desired range will result.

Agc circuitry

The first three stages use 2N247 drift transistors. These transistors have high gain through the highest frequency used and, because of their very low base-to-collector capacitance, do not need neutralization. The converter and if stages are entirely con-

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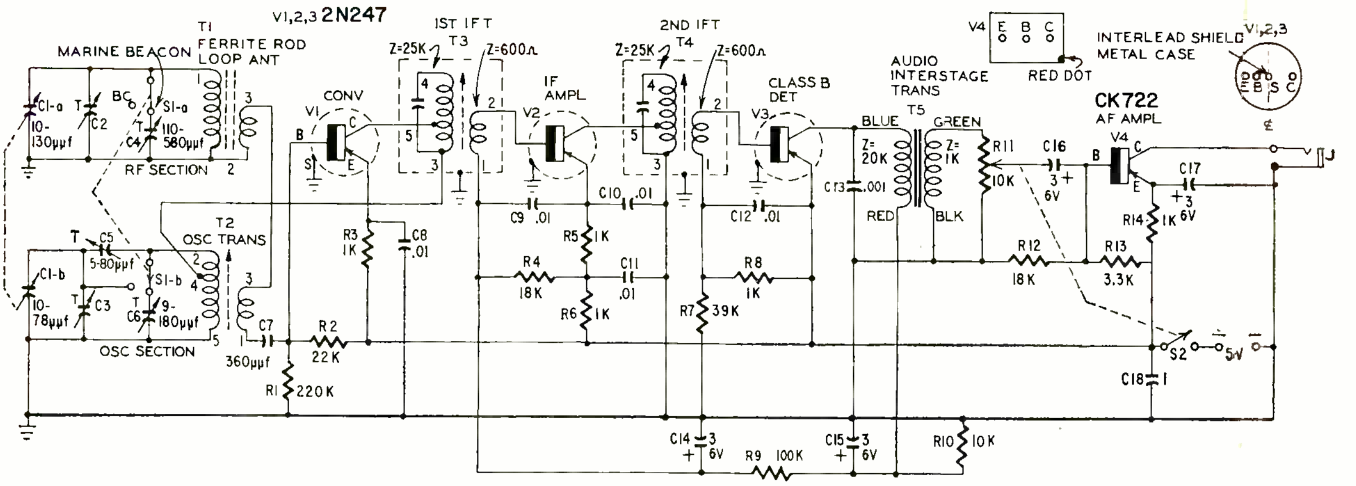

R1—220,000 ohms
R2—22,000 ohms
R3, 5, 6, 8, 14—1,000 ohms
R4, 12—18,000 ohms
R7—39,000 ohms
R9—100,000 ohms
R10—10,000 ohms
R11—pot, 10,000 ohms, miniature, with spst switch S2 (Lafayette VC-28 or equivalent)
R13—3,300 ohms
All resistors ½-watt 10%
C1—tuning capacitor; antenna section, 10–130 μμf; oscillator section, 10–78 μμf
[illegible] trimmers on C1
C4—[illegible] trimmer (El Menco 467 or equivalent)
C5—5–80 μμf, trimmer (El Menco 462 or equivalent)
C6—9–180 μμf, trimmer (El Menco 463 or equivalent)
C7—360 μμf, silver mica
C8, 9, 10, 11, 12—.01 μf
C13—.001 μf, ceramic
C14, 15, 16, 17—3 μf, 6 volts, miniature electrolytic
C18—1 μf, paper, miniature
J—miniature phone jack (LaFayette MS-281 or equivalent and matching plug)
S1—dpdt rotary (Centralab 1462 or equivalent)
S2 —spst on R11
T1—ferrite-strip transistor antenna for 130-μμf tuning capacitor (Miller 2005 or equivalent)
T2—transistor oscillator coil for 78–100-μμf tuning capacitor (Miller 2022 or equivalent)
T3, 4—transistor if transformer, 455 kc: primary, 25,000 ohms; secondary, 600 ohms (Miller 2041 or equivalent)
T5—transistor audio interstage transformer: primary 20,000 ohms; secondary, 1,000 ohms (Merit A-2741 or equivalent)
V1, 2, 3—2N247 (RCA)
V4—CK722 (Raytheon)
Battery, 5-volt mercury type (Mallory TR-134R or equivalent)
Battery holder (Acme type 69 or equivalent)
High-impedance magnetic earphone
Tuning dial (Lafayette KN-26 or equivalent)
Knob for ⅛-inch shaft
Knob for ¼-inch shaft
Bakelite instrument case, 2 x 3¾ x 6¼ inches (Lafayette MS-216 with matching cover)
Marching compass (Lafayette F-15 or equivalent)
Transistor sockets, 5-pin (4)
Miscellaneous hardware

Circuit of the four-transistor unit.

ventional, while the detector is a class-B type instead of the usual diode. This detector provides a worth-while gain and a dc collector voltage that can be used for avc, since its level is determined by the rf signal level.

Resistors R9 and R10 are part of the V2 base-biasing network and R10 is also in V3's collector circuit. The avc voltage developed across R10 is applied to V2's base to regulate its gain with variations in carrier level.

The audio transformer (T5) is a subminiature type well suited for this application. It as well as all other components must contain a minimum of iron to minimize errors in the magnetic compass. *A larger transistor audio transformer will not be satisfactory unless it is mounted far from the compass.*

The earphone is a high-impedance magnetic type and is satisfactory where the signal level is high and the noise level low. Sometimes, these conditions may be reversed, making a conventional pair of headphones more desirable.

A 5.0-volt mercury battery powers the unit. It has a 1,000-milliampere-hour rating and should provide about 500 hours of service since receiver drain is only about 2 ma. When near the compass, this battery has a slightly greater influence on needle deflection than conventional flashlight cells but, when mounted as shown in the photos, its effect is not measurable. The battery is easily replaced when the bottom of the case is removed.

All stages use base-bias stabilization to minimize variations in performance caused by temperature changes since the electronic compass will normally be used outdoors and frequently in the hot sun.

The magnetic compass is a small marching type. It has a rotatable scale for ease and accuracy of bearing determination. A notch and foresight on the compass let you select landmarks (when visible) in line with the desired course.

Let's put it together

All parts of the receiver are mounted on a long flat aluminum lower plate and a short flat aluminum upper plate as in the photos. The unit is fastened into the plastic instrument case with a second hex nut and lockwasher on the threaded switch bushing and with screws that run through the case into two threaded holes along the outer edge of the upper chassis plate.

The compass is mounted near the front end of the case with the needle pivot along the center line of the long dimension. Take your time while aligning the compass to insure the best possible accuracy. The rear mounting screw is a 6-32 flat head in a countersunk hole to permit the compass cover to be closed. The front mounting screw can be a round head but both *must be brass with brass nuts.* (Try them with a magnet.)

The aluminum chassis plates are shaped to fit the inside of the case with about 1/16-inch clearance on all sides. Make sure of this clearance after bolting to the tuning capacitor and switch but before the complete assembly of small parts is made. Otherwise, when the receiver is fastened in the case, pressure on one of these plates could upset the alignment by twisting the tuning capacitor.

One of the easiest ways to register the receiver parts with the case is to drill all necessary holes in the upper chassis plate. Then use this plate as a template for drilling the case *from the inside.* Be careful while drilling and avoid chipping. This problem can be minimized by backing each hole with a wood block while drilling and by making each hole somewhat undersize and bringing it to size with a tapered reamer.

The tuning capacitor is mounted with its trimmers facing the outer edge of the chassis for easy adjustment. The adjustment screws should be about ⅛ inch from the outer edge of the chassis to provide adequate spacing between their heads and the plastic case.

One of the mounting holes on the rear of the tuning capacitor matches the corresponding front hole and the top chassis plate can be used as a template to locate this one. The other two must be located by measurement. If the same tuning dial is used as shown, the capacitor shaft will need to be flattened slightly on one side but its length will be satisfactory.

Final assembly

The oscillator coil can be fastened to the bottom chassis plate if desired but a better arrangement of terminals is possible if it is mounted on the top plate. To do this, remove the metal mounting clip and cement a threaded plastic plug in this end. A setscrew in a threaded hole in the top chassis plate is then used to hold the coil. A small hole is drilled in the lower plate directly below the coil for adjustment.

Mount the antenna by first cutting

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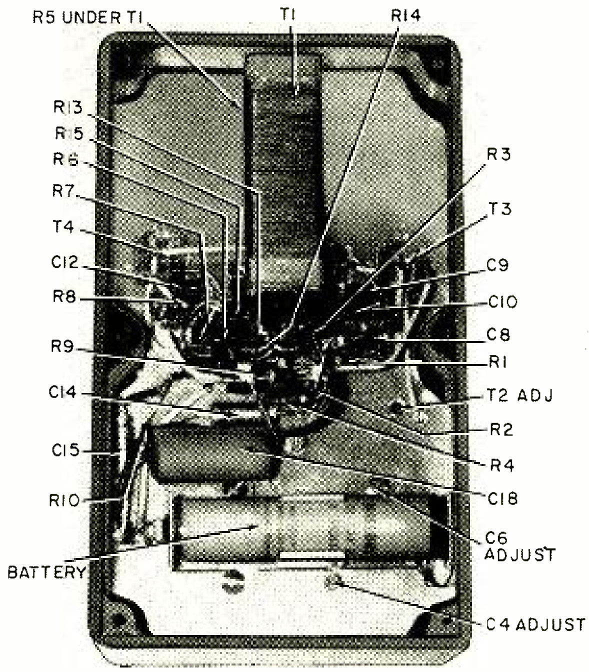
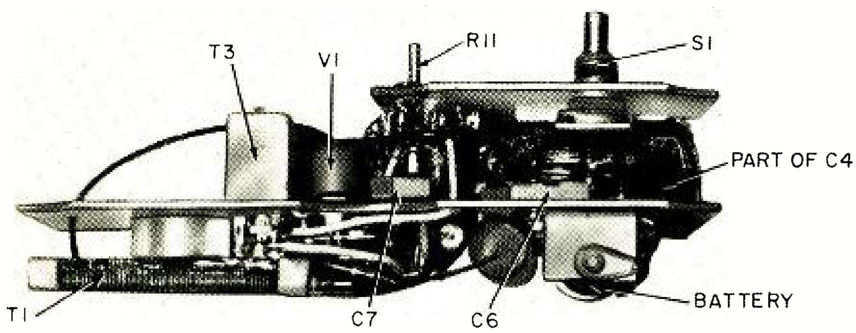


Although there is plenty of room, placement of the antenna and battery is important.



Side view shows parts layout between the two chassis plates. In this model a small mica capacitor in parallel with C4 was needed.

its fiber mounting strip about ⅜ inch shorter than the antenna. Then retape the antenna to this strip with their front ends flush and apply a small amount of coil dope along the joining edges. The undercut end allows room for some parts underneath. A ⅜-inch piece of ¾-inch-diameter polystyrene rod is threaded for two 6/32 x ¼-inch screws, and matching holes are drilled in the lower chassis plate. Mount this piece of rod on the plate and fasten the antenna to it with polystyrene coil dope, making sure that the antenna is parallel to the long side of the chassis.

Capacitors C4 and C6 are positioned so that their adjustment screws just clear the battery holder (see photos). These capacitors are mounted directly under the range switch with their outer plates making contact with the chassis. Their end terminals are soldered to the switch and their grounded terminals are bent over and soldered together for rigidity. Examine the ungrounded plates and rivets to be sure the "hot" ones are not grounded.

Both these capacitors should be set to within one-half to one turn from maximum capacitance before soldering. Capacitor C5 is mounted in the same way as C4 and C6, except that it is insulated from the chassis with a small piece of 1/16- or ⅛-inch insulation.

The if transformers are mounted along the sides of the chassis to reduce their effect on the magnetic compass, and the audio transformer is mounted directly in front of the volume control with a couple of dabs of cement.

A two-terminal tie point is used for B-plus and for the R9, C14, T3 junction. A ground lug is located under the mounting screw and a No. 20 bare wire connected to it is used as a ground bus. This bus is connected to the shield terminals of the three 2N247's and various small parts are grounded to it along its length. Rubber feet are mounted on each corner of the case to prevent slippage if the weather gets rough.

Steps in weatherproofing

If the electronic compass is to be used in salt-water areas, some weatherproofing will be necessary. Even in fresh-water areas the possibility of wetting by rain, spray and high humidity and falling overboard will make such a step profitable. First obtain some sheet rubber, about 1/32 inch thick, and cut a gasket about ⅛ inch wider on all sides than the bottom cover. Now, with a file, trim the base plate to give a clearance of slightly less than 1/32 inch between all of its edges and the case, and chamfer its inner edge slightly. Glue the rubber gasket to the inner surface of the base plate and allow it to dry thoroughly.

Gaskets made of the same material can be placed under the compass securing nuts, under the switch shaft nut and under the upper chassis securing screws. The tuning control shaft, the switch shaft, the volume control shaft and the phone jack can be gasketed by splitting soft rubber grommets edgewise. Use grommets with a ½-inch outside diameter and ¼-inch hole for the three controls and ⅜-inch outside diameter with a 3/16-inch hole for the phone jack. In addition, it is advisable to spray the aluminum chassis and if transformer cans with clear plastic to provide an extra degree of protection.

Aligning the receiver

The first step is to align the if transformers for maximum output at 455 kc. An output meter or oscilloscope can be connected across the headphones, or a high-impedance dc voltmeter to V3's collector or the R10, C15, T5-re[illegible]tion for an output indicator.

After the if transformers have been peaked, turn the bandswitch to the broadcast-band position (BC) and adjust T2's core and C3 until the tuning range covers 550–1,600 kc. This is done by alternately adjusting T2's core at 550 kc and C3 at 1,600 kc until both ends of the range fit the dial. Next adjust C2 for maximum output at approximately 600 kc and check for satisfactory tracking at 1,400 kc. If C2 has to be decreased for maximum output at 1,400 kc, bend the slotted plates of C1-a outward and then readjust C2 for maximum output at 1,400 kc. Now adjust for maximum output at approximately 600 kc by simultaneously varying the tuning capacitor in very small steps and adjusting T2's core until the maximum is found. Alternately repeat the C2 adjustment at 1,400 kc and the T2 core adjustment at 600 kc until maximum output is obtained at both points.

The next step is to align the radiobeacon band. Throw switch S1 to RADIO BEACON and alternately adjust C6 at 285 kc and C5 at 325 kc until this range fits the dial. Next, adjust C4 for maximum output at approximately 290 kc and check for satisfactory tracking at 320 kc. *When aligning this band, do not touch the core of T2, C2, C3 or the slotted C1-a plates, as these parts are adjusted only for the broadcast band.* When alignment is completed, you can calibrate the dial.

How to use it

When the electronic compass is completed, check its accuracy by obtaining the null point on a visible station and at the same time checking to see that the station is directly in line by using the sights on the compass. If possible, check stations at various frequencies

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in both bands. These checks should be made some distance from the station antenna and well away from any shore line, electric or telephone lines, metal buildings, or automobiles for maximum accuracy. In addition, hold the compass with the hands away from the antenna end of the case.

The overall accuracy of the electronic compass depends on antenna pattern, compass accuracy, compass alignment with respect to antenna, size and proximity of metal objects, and the nearness of a shore line and the station antenna. The compass error including alignment error should be very small. If any sizable error should be present, it can be compensated for by adding or subtracting a correction factor.

To use the electronic compass with the least amount of error and confusion, obtain a map of the area in which you will be operating. First mark a North–South line through the section of the map to be used and locate all the radio broadcast and beacon stations in your area on the map. Now set the North mark on the compass card under the red hairline, align one edge of the electronic compass case with the North–South line on the map, and rotate the map until the compass card North is aligned with the North end of the needle.

This orients the map so its North is pointed North. Now rotate the electronic compass (but not the map) to obtain a null on a station of known location, place one edge of the electronic compass to intersect with this station as located on the map while maintaining the null and draw a line through the station along the edge of the case. Do the same with a second station. The point where the two lines intersect is *your* location. Now that you know your location, it is a simple matter to get home either by following a plotted course to the desired point or by riding the null straight in if one of the stations is near your destination.

Satisfactory results can be obtained without the map. Simply use the compass to orient yourself with respect to North and then take compass readings on the null points of two stations of known location. The compass card is calibrated in degrees (0 to 360) and also has the usual *N, E, S, W* markings. Therefore, the readings on the two null points will immediately show you where you are with respect to the two stations. For greatest accuracy, keep your hands away from the antenna end of the case.

After making several trial runs using both methods, you will be able to decide which you prefer—with or without the map. However, try using the electronic compass each time you are engaging in your favorite outdoor activity, even in clear weather, to become completely familiar with it and to gain confidence in its usefulness.

For those who are interested, the US Coast Guard publishes lists of lights for the US coastal and Great Lakes areas. These light lists include a chart and tables of the various radio beacons including their frequency, identification code and location. Write to the Superintendent of Documents, Washington 25, D. C., for information and prices.

Final notes

Sensitivity, on the broadcast band, will be adequate for nearly any condition, but the radio-beacon range may need a slight boost if there are no nearby stations. In such cases, try a 5- or 7-inch ferrite antenna instead of the 2¾-inch one used in this model. This longer antenna will also increase the sharpness of the null point. A second if amplifier can also be added if so desired. This stage is identical with the V2 stage, except that the resistor corresponding to R6 should be about 3,300 ohms.

A speaker can be included by adding a pair of CK722's in a conventional push-pull class-B output stage after V4. Also a null-indicating meter can be added to V3's collector circuit to obtain a sharper null reading. All of these changes will require a somewhat larger case and will cause a slight loss of portability.

(When adding a speaker or null-indicating meter to the direction finder, be sure to mount them in a place where their magnets will not disturb the magnetic compass. It might be advisable to install the meter and speaker in a separate box connected to the receiver by a cable.—*Editor*)

For some uses it may be desirable to attach a leather or plastic shoulder strap to two *brass* screws mounted on the sides of the case, below the compass but above the receiver chassis.

Where you want to eliminate the radio-beacon band, delete S1, C4, C5 and C6. The tuning capacitor shaft can now be aligned with the center of the chassis, or the extra space can be used for a speaker. END

Communications In a Hurry

TENNESSEE stands ready to meet any emergency—flood, tornado, forest fire or explosion—with its unique mobile disaster communications bus.

Moments after arriving on the scene, the bus offers six radio sending and receiving sets which can operate simultaneously, first-aid equipment, a generator which can supply outside power and an emergency field kitchen.

The unit, operated by the Tennessee Highway Patrol and Civil Defense Organization, is available for use anywhere in the state and surrounding states.

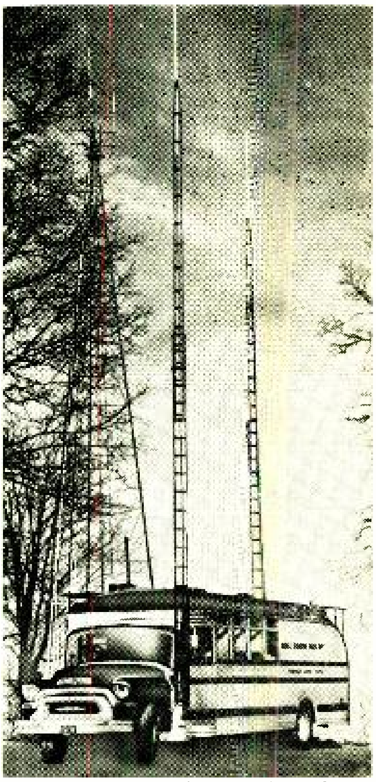
The planning of Capt. P. E. Griffith, of Nashville, Tenn., made it possible to jam so many features into so little space. Captain Griffith heads the communications division of the Tennessee Highway Patrol which also handles communications for the State Highway Department and Civil Defense.

The bus is divided into three compartments, all in radio contact with each other. The front section houses the driver and six radio booths. From here, six radiomen can simultaneously direct operations of six service units.

The center compartment houses 10 transmitters which enable the center to use 40 frequencies, including those of public-service groups both in Tennessee and surrounding states. This section also contains the kitchen unit. Room was made for the field kitchen, Griffith noted, because frequently rescue workers at tornadoes and similar emergencies had gone 15 hours without food.

The rear portion holds first-aid equipment, including a respirator and generator. The generator can be rigged to supply power outside—to a hospital, for example.

The bus has two complete public-address systems and outside plugs to supply power to other electrical units.



Tele-Vue Towers, St. Petersburg, Fla.

This Tennessee Highway Patrol and Civil Defense mobile communications unit is equipped to handle any emergency.

Everything is geared to place units in operation almost instantaneously on arrival at the disaster scene. For example, the Tele-Vue aerial towers lie flat along the top of the bus while it is in motion. But as fast as cranks can be turned, they are hoisted to vertical positions and a second set of cranks swiftly telescopes them up to 45 feet in height. The bus cost $14,442.

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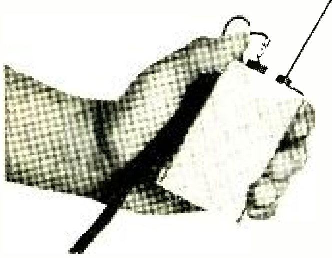
Miniature fixed-frequency superregenerative receiver that can be held in the palm of your hand. May be set for frequencies between 30 and 45 mc

3-TRANSISTOR Pocket Police Receiver



By EDWIN BOHR

THE idea of owning a police receiver is always intriguing. Interest spans all age groups from children to grandparents. There is a thrilling vicarious experience; listening to emergency broadcasts is exciting to all but the most blase.

Added to this, we have an extra-special police receiver. It is hand- or pocket-size and completely transistorized. Its operating frequency range is about 30 to 45 mc.

The small size makes it ideal for auxiliary police, Civil Defense workers, merchant police, ambulance crews and the like. Also, it is just the thing for those who like to know what is going on.

The circuit is simple and there are few parts (see diagram). One of the transistors is a surface-barrier type. It is used just like a p-n-p fused-junction type. However, SB units can operate at very high frequencies.

The SB transistor is used as a high-frequency superregenerative detector. The other two transistors are audio amplifiers.

The receiver, as illustrated, is a fixed-frequency type. Tuning can be changed only by adjusting C1 through a hole in the case, and even the amount of *superregeneration is set at a fixed value*. These are desirable features, since they eliminate controls.

Receiver sensitivity

To appraise its performance, here is a report on the receiver in use. However, bear in mind that signal strengths vary tremendously in this type of service.

From experience, the audio output is strong and clear 5 miles from a central police transmitter. Reception is usually good, even without an antenna. Reception of patrol cars or utility-truck transmissions is another matter. Unless the vehicle is very close, audio is weak and garbled.

This circuit has been used with a third audio stage and a small speaker. Still, earphone operation seems preferable for one-man listening. If a third stage is added for speaker operation, considerable audio decoupling is necessary to eliminate motorboating.

Detector circuit

The superregenerative detector is the receiver's nerve center. Superregeneration develops tremendous amplification in a single stage.

Inherently, the superregenerative detector is not very selective. Also, it has a natural automatic volume control action.

With rare exceptions, the stations in the 30–60 mc band are narrow-band frequency-modulated. The pocket police receiver picks up these stations by slope detection.

Because the detector is broadly tuned and the frequency swing is very small, audio output from the detector is low. This makes the two medium-gain audio stages necessary.

The superregenerative detector's selectivity can be sharpened somewhat by setting the value of superregeneration carefully. In fact, it *must* be set for greatest selectivity for really good performance. This procedure requires a signal generator and is explained later.

The maximum frequency at which the detector will superregenerate depends upon the Q of the coil, transistor characteristics, the value of C2, the position of the coil tap and transistor bias.

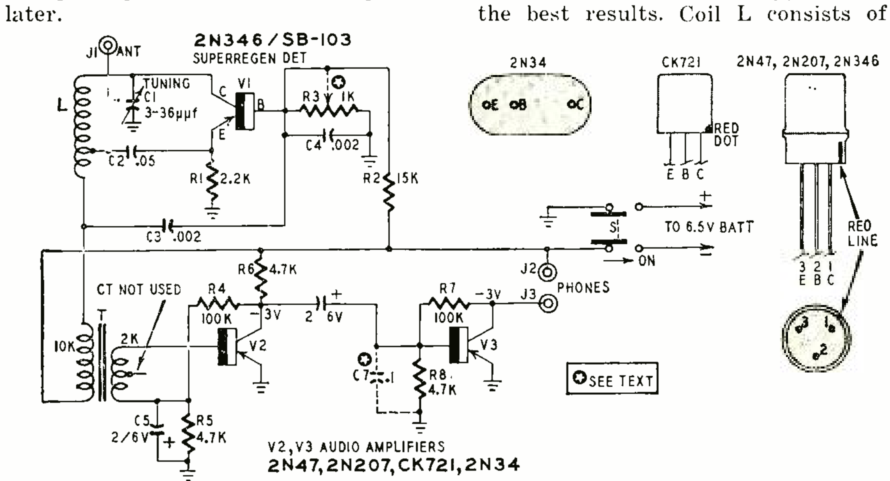
To operate the receiver at 40 mc or higher, you may have to juggle or vary all of these values for maximum superregeneration.

High-frequency performance is particularly dependent upon coil L. For this reason, we will give it special mention. First, the coil must be kept away from the sides of the case, transformers and other metal parts. If at all possible, use a larger metal case, a plastic case or no case at all. Test the circuit before placing it in a case.

The receiver I built operated up to 45 mc before placed in its case. In the case, it works to about 39 mc. I used a selected, hot-performing 2N346/SB-103 transistor. Other units may not perform as well.

A lot of experiments were carried out with some of the completely shielded miniature iron-core coil forms now available. These would do away with effects caused by nearby components. But, because their performance was lower initially, they made no improvement.

I found the Miniductor type coil gave the best results. Coil L consists of 7



R1—2,200 ohms
R2—15,000 ohms (see text)
R3—1,000 ohms (see text)
R4, 7—100,000 ohms
R5, 6, 8—4,700 ohms
All resistors ½-watt 10%
C1—3-36-μμf trimmer (Bud MT-833 or equivalent)
C2—.05 μf ceramic, subminiature type
C3, 4—.002 μf, disc ceramic
C5, 6—2 μf, 6 volts, miniature electrolytic
C7—0.1 μf ceramic (see text)
J1, 2, 3—pin jacks
L—7 turns, tap at 2¼ turns (Barker & Williamson type 3003 Miniductor)
S—dpst slide
T—driver transformer; primary, 10,000 ohms; secondary, 2,000 ohms ct (Argonne AR-109 or equivalent)
V1—2N346/SB-103 (Philco)
V2, 3—2N47 (2N34, CK721, 2N207 may be substituted)
Battery, 6.5 volts (Mallory TR-165R or equivalent)
Terminal board
Case
Miscellaneous hardware

Circuit of the miniature receiver.

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turns of a B & W No. 3003 coil, tapped at 2¼ turns. This coil is ½ inch in diameter, with a pitch of 16 turns per inch.

Resistors R2 and R3 control superregeneration. I found that, with fixed frequency operation, fixed values of resistance can be used. For each individual receiver and frequency, however, these values will have to be changed for best performance. Either decrease R3 or R2. (Decreasing R2 has an opposite effect from decreasing R3.)

To make superregeneration variable, substitute a 1,000-ohm potentiometer for R3 and connect the center terminal of the control as indicated by the dotted lines in the schematic. Also, decrease R2 to 10,000 ohms.

Capacitor C2 should be a subminiature ceramic. The rather large value for C2 is necessary for superregenerative action.

Another essential is transformer coupling. The transformer characteristics have an effect on the detector's quench action. The Argonne AR-109 or something very similar should be used.

Only surface-barrier transistors will work properly in the detector circuit. The 2N346/SB-103 made by both Philco and Sprague is satisfactory (so are the military types 2N128 and 2N129).

The prices of surface-barrier transistors have recently been reduced. Now they do not cost much more than high-frequency junction types.

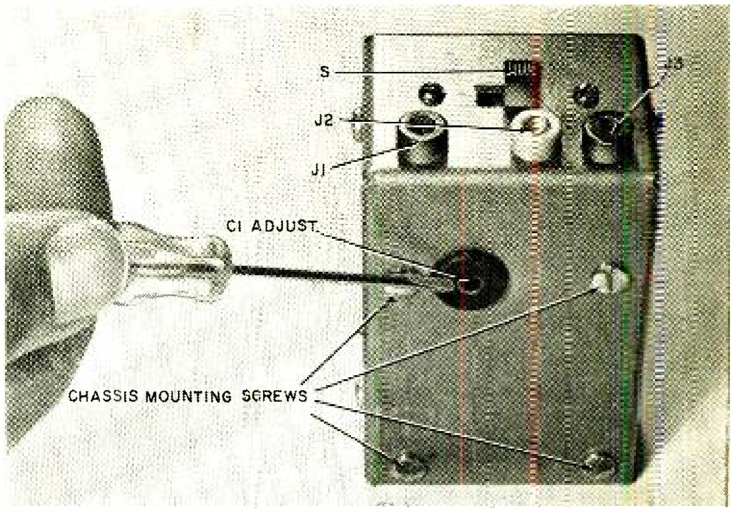
Audio amplification

The two audio transistors have medium beta (current-gain) figures—about 40 to 45. Any other p-n-p transistor with about the same gain is suitable. I used 2N47's, but as this transistor has been discontinued you may not be able to get any. The 2N202, 2N34 or CK721 can be substituted without making any circuit changes.

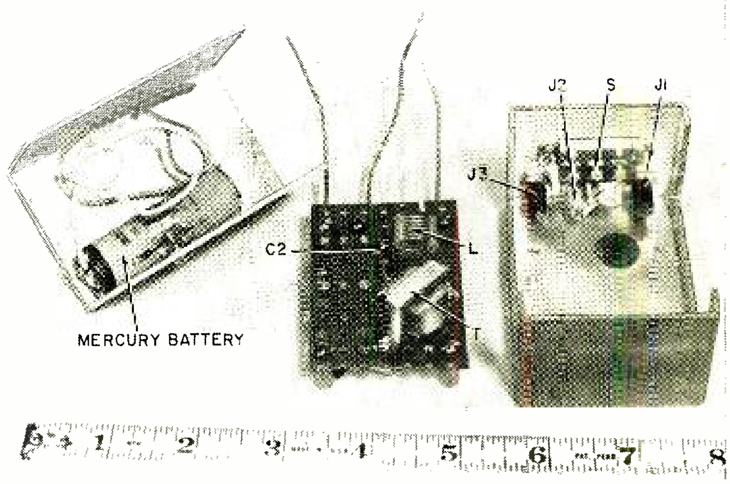
Direct-current feedback stabilization is used. While this is not as good as having emitter stabilization, it is sufficient and saves the space occupied by two emitter bypass capacitors.

The feedback does not compensate for individual transistor variations, but it does hold temperature changes of the collector current to a reasonable amount. The circuit works like this: If collector current tends to increase because of temperature effects, collector voltage decreases because of the drop across the collector load resistor. This, in turn, tends to decrease the base bias current and reduces the total change considerably. This bias method is infinitely better than just a single resistor from the base to the supply voltage.

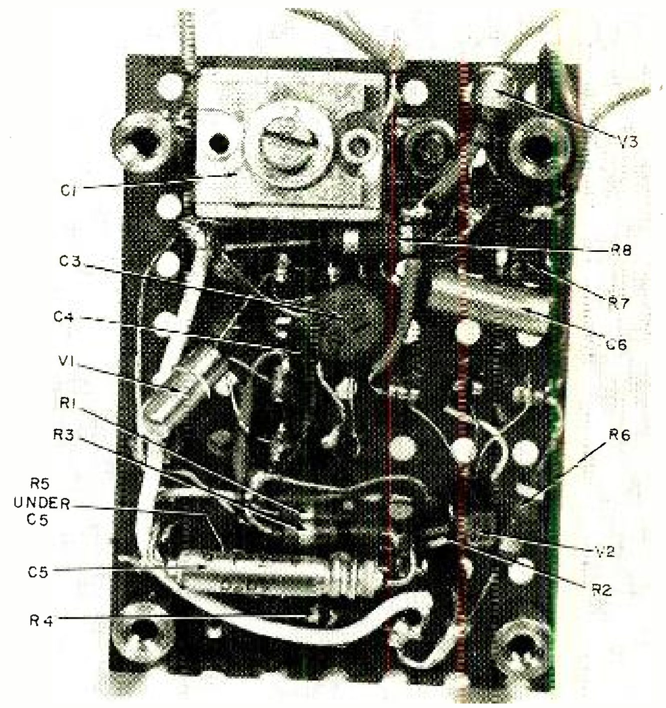
Collector voltage of transistors V2 and V3 should read −3 volts (±0.5 volt) using a 20,000-ohms-per-volt meter. If higher, *decrease* the value of R4 or R7, as the case may be, to *decrease* the collector voltage and vice versa.



The tuning adjustment can be reached through a hole in one side of the case.



Three subassemblies make up the completed receiver.



Most of circuit's components are mounted on a small phenolic terminal card.

If a 2,000-ohm earphone is used, R7 may have to be reduced to about 47,000 ohms.

You may find that listening is more comfortable when the optional capacitor C7 is added. Capacitor C7 suppresses the ultrasonic quench frequency before it reaches the earphones or overloads V3.

A small terminal card simplifies construction. The components are wired to the card. Then the card is bolted into the case with four brass standoff spacers.

The TR-165R mercury cell is clamped to the case cover with a piece of strapping material. Of course, a capacitor clip or battery holder could also be used.

My antenna is a heavy piece of Copperweld wire, about 12 inches long, that plugs into the antenna jack. Increasing the antenna length does not seem to improve reception very much. Too much antenna length will load the oscillator and reduce the maximum working frequency.

Final check

For reception of narrow-band FM, detector superregeneration must be set for maximum selectivity. To do this, a signal generator is necessary. Assuming the set is working, a hiss or frying sound is heard when the detector is superregenerating. With the antenna connected, tune the receiver to the carrier frequency. This is found by setting the generator at the carrier with tone modulation. Now, rock the tuning capacitor C1 back and forth and adjust the value of R3 until the sharpest selectivity is obtained.

Turn off the generator and listen for a police carrier. The instant the carrier is heard, turn *C1 very slightly* for best reception. This is necessary to account for inaccuracies in the signal generator's calibration and *because the detector must be tuned to one side of the carrier for slope detection.* In other words, best audio *will not* be obtained with the detector tuned exactly to the carrier.

If the detector does not superregenerate, check the connections to the surface barrier transistor. It is easy to confuse the emitter with the base lead.

Next, check the transistor voltages. There should be about 6 volts from ground to collector and, very roughly, 0.1 volt from emitter to base. The base should be negative with respect to the emitter. Also, check to see that none of the parts have been omitted.

When the receiver is first connected to the battery, set R3 at maximum resistance. This protects V1 if the battery is inadvertently connected with wrong polarity.

The pocket police receiver gives the constructor a new project, but it is not something for the beginner. I recommend the circuit only to those who have had some previous experience with transistor circuits and vacuum-tube superregenerators. END

Radio Runs on Low Voltage

By WARREN J. SMITH

With slight modifications, 3-way portable radios can be made to work on line voltage as low as 90

THREE-WAY portable radios often succumb to oscillator instability or failure when operated on the low line voltage in my locality (90 to 95 volts). These receivers almost invariably have a 1R5 or similar converter tube which is extremely sensitive to line-voltage fluctuation. The 1R5 cannot tolerate a drop in screen voltage of more than 10 to 15% without some ill effects. Filament voltage tolerance is even more critical. Although normally operated from 1.4 to the rated 1.5 volts, the tube functions erractically or not at all when filament voltage drops to 1.2 or 1.15. Many other portable radio faults not so readily apparent, such as low gain and poor sensitivity, can also often be attributed to low line-voltage operation.

To correct for inadequate supply voltage, I simply reduce the value of the power supply's dropping resistors or eliminate them. Resistance changes, as illustrated in the diagram, let this particular portable operate satisfactorily, while previous operation was extremely unstable and erratic. Normal battery operation is not disturbed by this type of modification since the altered circuitry is switched out with the ac-dc rectifier circuit.

Use a Variac or similar variable ac source to determine the dc output voltage of the selenium or vacuum-tube rectifier (points A and B in the diagram) with a normal input voltage of 117. (This information usually appears in the manufacturer's service notes, but it is best to make your own tests.) Next, measure the rectifier output voltages with an ac input voltage equal to the minimum and maximum extremes of line-voltage variation in your particular area. Then, from the following formula, determine the total value of filament-dropping resistance (R1) needed.

$$R1 = \frac{\left(\frac{E_a max + E_a min}{2}\right) - E_f}{.05}$$

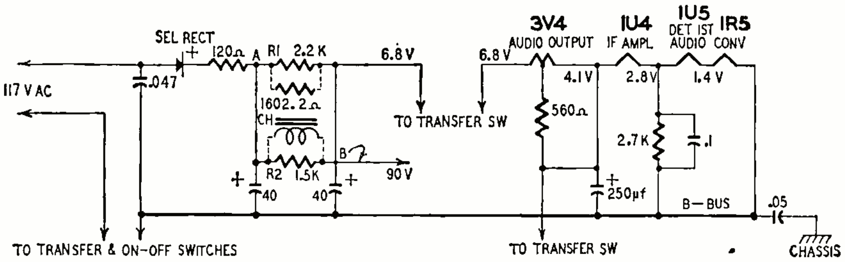
where $E_a$max and $E_a$min are the measured maximum and minimum extremes of rectifier output voltages at point A, E_f the total voltage drop of the filament string.

Substituting actual values for line operation in our area (for the Emerson portable shown in the diagram):

$$R1 = \frac{\left(\frac{84.7 + 89.1}{2}\right) - 6.8}{.05} = 1{,}602 \text{ ohms}$$

The closest standard resistance value, 1,500 ohms, is much too small. Therefore a series, a parallel or series-parallel combination of resistors must be made up. In this particular instance I used a series combination of standard values—1,500, 100 and 2.2 ohms for a total of 1,602.2 ohms.

In the portable used as an example, the dropping resistor in the B-plus line



Power supply circuit of an Emerson portable. Parts shown in dashed lines replace existing components.

was unnecessary because an ac input of 90 to 95 volts (our line voltage) produced a variation of 84.7 to 89.1 volts at the rectifier output for an average of 86.9 volts. This represents a drop of only 1–6% in the B-plus voltage compared to the previous example of 12–23% with the 1,500-ohm dropping resistor. (A small, low-dc-resistance choke was wired in the circuit in place of the dropping resistor for filtering purposes —its resistance is negligible but it does provide a margin of safety.) If a dropping resistor in the B-plus line should be required, use the following formula to calculate its nominal value:

$$R2 = \frac{E_{av}}{\left(\frac{E_{na} - E_{nb}}{R_n}\right)}$$

where E_{av} is the average of the low line voltage as determined from

$$\frac{E_a max + E_a min)}{2}$$

E_{na} is the normal voltage at point A and E_{nb} is the normal voltage at B with an input of 117 volts ac and R_n the original value of the B-plus dropping resistor (R2). END

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IDENTIFY THAT CHASSIS

A little detective work is all it takes to pin a model number on an unmarked chassis. Just follow the Old-Timer along as he shows you how

By JACK DARR

THE Old-Timer grunted loudly as he burned the tip of the finger he had unwisely poked into the small TV set he was working on. "Oww! Dad-burn it!" he grumbled. "I'll bet you I know what would be good useful equipment for a TV man—a set of asbestos fingers! Ouch!" and he sucked the damaged digit. The Young Ham, meanwhile, sat quietly at his end of the long bench, his crew-cut head bent over a car radio. Suddenly, he exploded.

"Darn it all!" he glared at the little chassis. "Why can't people put model numbers or somethin' on their radios! You'd think they were ashamed of 'em!"

"Well, some of 'em may be, and some of 'em ought to be," agreed the Old-Timer, looking up. "What's your trouble, Junior?"

"Aww, this little stinker!" growled the Young Ham. "No model number, no nothin'! This resistor's burned out, and I can't find anything on the set. How the heck do they expect us to fix 'em if you can't find out something about 'em?"

"Get out your crystal ball!" The Old-Timer grinned. "Let's see it." He got off his stool and ambled down to the end of the bench. "Ohh. That oughta be simple. I've seen several of them before."

"Well, I haven't!" burst out the Young Ham. "I can't tell beans from bones about it!"

The Old-Timer smiled at the young man's use of one of his own favorite expressions and studied the set closely. "Well, now, look here," he said, pointing into the upturned bottom of the set. "See that bypass? Says 'Bendix' on it, very plainly, don't it? Transformer does, too. Don't that tell you something?"

"OK, OK! So it's a Bendix, but what model? I've looked over the whole thing, case, lids and all, and I can't find anything on it at all!"

"Hang on, help's comin'," said the Old-Timer, reaching up to the well-filled bookshelf that ran the whole length of the shop. "You remember what kind of a car you got it out of, don't you?"

"Ford," said the Young Ham. "'53 Ford."

"Now, lessee; Chrysler, General Motors, Ford! Here we are," and he pulled a service manual down. "Now, look. Here's a Rider manual covering all the Ford radios from quite a ways back. '53 Ford, you say. Lessee. '52, '52. Here. See? Here's a picture of the front of the set. See? Looks somethin' like it, wouldn't you say?"

"Yeah! That's it!" said the Young Ham. "Now, let's see what that resistor was, before it burned up. Here it is. 1,800 ohms. Now, by golly!"

"Ah, Junior," said the Old-Timer quietly. "Ain't you a mite previous. Are you sure that's the same set?"

"Sure. Look at that front panel and the controls. Same set, see?" and the Young Ham pointed at the photograph.

"Well, that's true, but there might be one little difference. There was three people made Ford radios that year, Sylvania, Zenith and Bendix, according to the book. The one you're lookin' at happens to be a Zenith. Since when did Zenith start usin' Bendix capacitors and transformers? Huh?"

"Huh? Oh! I see what you mean," said the Young Ham sheepishly. "Got too previous, didn't I? Now, let's see in the Bendix set. Hmm. 1,000 ohms. Oopps!"

"Yeah, you did get a mite quick," agreed the Old-Timer. "Now, you see what too much speed can do. It's a good idea to check up on everything before you make any rash moves, especially in a case like this!"

"Tell me, why in the world don't people put the model numbers and the maker's names on their radios and TV sets?" asked the Young Ham, as he replaced the resistor. "You'd think they *were* ashamed of 'em!"

"Junior, that's somethin' that'll never be known, I guess," opined the Old-Timer, as he replaced the cover on his little TV set. "That problem's puzzled radiomen since 1920, and it would have before that, except they didn't begin to make sets until that year! Only way you can find out anything about 'em is by a long and painful process of deduction. Got that resistor in yet? I want a coke, while I let my fingers cool off. Danged little tubes sure do run hot!"

Let's go for a coke

He was answered by a burst of rock and roll music from the car radio, and the Young Ham snapped it off. Leaping up, he announced, "I'm ready! Let's go!"

The pair trotted down the long hall and out the back door. As they crossed the alley and took their regular short-cut through the drugstore, the Young Ham said, "Gee, I wish I could find 'em that quick! I'd have been hunting all day, and you found it in just a second!"

"Hi, Hop!" said the Old-Timer, as they passed the pharmacist at his prescription counter. "How's the poison shop today?" Ignoring the rude reply, they passed on out the front door and across the street. When they were seated at a table in the soda shop, the Old-Timer got around to replying to the young man's question. "Well, Junior, it ain't so much a matter of genius as it is a combination of experience and patience," he explained. "Time you've had that button nose into as many of the things as I have, you'll be able to recognize 'em on sight, too. Main thing is, you gotta take advantage of every little clue you can find as to who made the thing and when."

"Maybe so, but what do you do when you find a set that hasn't got any clues as to who made it?" asked the Young Ham.

"They ain't no sich," said the Old-Timer, truthfully but ungrammatically. "I don't believe it's possible to build a set without leavin' some kind of a clue. Y'see, the only ones we'll have trouble with is the sets from the mail-order houses and other outlets like that. They don't build their own sets; they buy 'em from the manufacturers who make a business out of makin' sets just for such people. In fact, there used to be set makers who sold more sets under other people's names than they did their own—Wells-Gardner, for instance. Haven't seen one with their own name on it for more than 20 years, but there was more WG's than you could shake a stick at. Sears Roebuck, Mont-

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gomery Ward, Walgreen, Spiegel—everybody at one time or another sold Wells-Gardner sets, I reckon!"

"Well, what do you do then?" asked the Young Ham. "Hey, how about a coke over here?" He pounded the table, then ducked quickly as the waitress flung a water-soaked paper napkin at him.

"Well, Y'see . . . glupff!" said the Old-Timer, as the wet paper wad took him squarely in the mouth. "Hey! Phoo! How'd *I* git into this argument? I'm just an innocent bysitter!"

The waitress rushed over and mopped the Old-Timer's face with her apron, much to the delight of the Young Ham, then brought their cokes. The Old-Timer stirred his, then tasted it, gingerly. "Well, that takes the taste of that paperwad outa my mouth," he commented.

"Wow!" said the Young Ham. "They sure do make it cold!" and he ducked again. This sally was ignored by both waitress and proprietor, and the two finished their cokes in peace. Going out the door, they trotted back across the street, through the drugstore and back to the shop. Reaching up to the bookshelf, the Old-Timer took down a thick blue-backed book out of a set there. Opening it on the bench, he located a diagram.

"Here's a good example of what I mean, about some of those old-timers," he said. "See here? Here's a Sears Roebuck set listed under their trade name, Silvertone. Now, looky here," and he turned to the back of the book. "See? Under Wells-Gardner, here's the same set—Look at the tube lineup, the circuit and so forth."

"Yes, I can see that," said the Young Ham, "but how are you going to tell just who made the thing if you've never seen one like it before?"

"Well, that's the hardest part," admitted the Old-Timer, "but there's a kinda method you can use on all of 'em and find out what you've gotta know. It's a kinda combination of every little thing you can see: the cabinet, the chassis, the tube lineup, the general appearance of the set and everything else about it. If they all agree, then you're home free. Some people use a code in the model numbers, that's a big help. Montgomery Ward's Airlines, f'rinstance, since about—lemme see, 1939, I think. Yeah. See here?" and he pointed out a listing in the index.

"How can you tell anything by that?" asked the Young Ham. "Just looks like a mess of numbers to me."

"Nope; they're just full of information, if you know how to read 'em," said the Old-Timer. "Look at this model number here. '93BR508A.' Turn the first two numbers around and you've got the year it was made: 93—1939. Then the 'BR' tells you that it was made by the Belmont Radio Co. or, if it was 'WG,' by our old friend Wells-Gardner, and so forth. That'll help, if you can find the year it was made."

"Where do you go from there?" asked the Young Ham. "Even if you do know the year, how do you find it in all that stuff," indicating the 20-foot bookshelf, filled with manuals.

Lots of service data

"Well, that's not too hard, either," said the Old-Timer. "All these Rider manuals are roughly numbered according to the year they came out, beginning with Vol. 1, which came out in 1930. So, if you wanted a set made in 1940, you'd be like to find it in Vol. 10, and so forth. Feller needs a pretty complete set of all the service data he can git his hands on, to do much of anything with this kind of work."

"Well, you've got that, I'll say that for you," said the Young Ham, eying the well-filled bookshelf and the stacks of assorted service information which covered nearly every flat surface in the shop.

"Yep, I have," admitted the Old-Timer. "And I use it all at one time or another too. Tell you what though. One of these days I'm gonna git in here and straighten out all of this stuff and file it like it oughta be! Lessee now, where were we?"

"You were talking about Airlines," said the Young Ham.

"Oh, yes. Now, look here. Here's another helpful soul—the Truetone sets sold by Western Auto Stores. They give you model numbers with codes in 'em, too. See this one? Model D-1191WG: 'Factory No. 6C18-3.' This means Wells-Gardner again. If it was BRC, Belmont; DRT, Detrola, and so on, just like the others. Then, you can look this up under Wells-Gardner and probably find it listed under model 6C18."

"Tube lineups are helpful, too," he continued, "especially on the older sets and once in a while on the new ones. Take this guy here, f'rinstance. Look. He's used a 12J5 as an oscillator and a 12SA7 as only a mixer tube, instead of using the 12SA7 as both. Well, all you have to do is look through your manuals until you find somebody else using the same circuit with the same tubes, and you've got him. Lots of other little peculiarities like that, if you take the time to look 'em up. Certain designers have certain habits and the chances are they'll use 'em over and over again, for several years, anyhow. If a certain guy uses a kind of trick circuit one year, you can be fairly sure that you'll find the same circuit in several sets, especially if it works fairly well!"

"You mean they use the same circuits in all the sets?" asked the Young Ham, with a bewildered look.

"No, not at all," answered the Old-Timer. "What I meant was just certain parts of the circuit, like the if's, the oscillator stage, the front end and so on. Take Philco, for instance. One year they used an if stage with a little tertiary winding in the if amplifier screen circuit. Well, they used that same circuit for at least three years. So, if you had if troubles and couldn't find the right diagram, you could look up the same circuit in another set, even if it was a year later. See?"

"Oh, I get it, now," said the Young Ham: "You can kinda make up enough information to get what you need, even if you have to use the diagrams of several different sets!"

"Now you're getting the idea." The Old-Timer applauded. "It's not where you find it, but what you find! There's a heck of a lot more service information available now than there was when I started, too. Why, they're even pasting schematics inside the cabinet on a lot of sets now, and that's a big help. TV sets, well, that's a different story. A TV set's a heck of a lot more complicated than a radio, and there's still a heck of a lot of variation between makes as to the different circuits. Thank goodness, they're beginning to settle down some by now, though. Different manufacturers are beginning to use the same circuits in the same places, with only minor variations here and there. Like the high-voltage supply—I guess about everybody uses the same general circuit by now. You don't find any more line-voltage supplies with the tremendous transformers, or rf power supplies with the separate oscillators and stuff like that, that we had in the early-day sets, and hurray for that!"

"No, sir, TV sets are not all alike, yet," agreed the Young Ham. "Not with all the funny tubes they're coming out with now."

TV set clues

"Well, that's sometimes a hindrance and sometimes a help," said the Old-Timer. "Some manufacturers have a habit of using certain tubes. That'll help you identify their sets, no matter what name they're under. For instance, Zenith used the 6BN6 tube as the sound discriminator for several years and no matter what set you had, if it had a 6BN6, chances are it was a Zenith. Now, we've got the same situation in

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TV that we had in radio. Different makers are selling sets to chain stores, mail-order houses, and so on. The only way you can tell what kind of a set it is is to give it the same treatment. Look it over careful, check for brand names on the tubes, transformers and so forth. Look at this one here. This is an easy one." The Old-Timer indicated a small TV console in the finished-work department. "Says 'Truetone' on the cabinet, but look at it closely. What does it look like? We've had several of them in here lately, from ol' Walker's, down the road. Recognize it?"

"Why, it looks just like those—Oh, what was the name of that set—Oh, yes! Raytheon! That's what it is, a Raytheon!" said the Young Ham, excitedly.

"Kee-rect the first time," said the Old-Timer. "You'll also find that same set under Silvertone—had one the other day, out on 15th St. And, you know Ol' Dingbat's Stewart-Warner? The Gasman's? The 9300 series? I found one of them the other day, carrying a Silvertone nameplate, but it was a Stewart-Warner 9300 'cause the first thing I spotted was that characteristic heavy metal bridge over the yoke. That's another thing you want to remember. Look for characteristic construction features—like that bridge, or something distinctive. For instance, maybe some company always mounts their tuners way out to the side, actually off the main chassis. That's a trademark. Maybe they use a certain given kind of printed-circuit assembly—like Westinghouse or Admiral or G-E. Why, I even identified an Airline TV set one time by the dern knobs! It turned out to be a Bendix and they had those peculiar cutout knobs, with the inside shaft on the outside knob, and so on. Nobody used them that year but Bendix, and I spotted it that way!"

"Gosh, it'd take you a lifetime to learn all of the darn things," sighed the Young Ham in discouragement.

"No, not necessarily," said the Old-Timer. "All it takes is a pretty good memory for those little quirks and characteristics I've been talkin' about, and the ability to put 'em all together and make 'em spell out the name of the set. That, and somethin' you could use just a wee bit more of—patience!"

"Who, me?" said the Young Ham, aggrievedly.

"You," rejoined the older man. "In common with all kids, you want to git everything done today! Don't forget, there's always tomorrow, and you've got plenty of time! Take it slow and easy, and be sure you're right before you go ahead.

"But, back to the subject of identification. It's only once in a while you really need a schematic, especially since so many people got thoughtful and started puttin' tube layouts inside the cabinets on TV sets. Why, some actually put the heater string layout in the sets with series heater circuits and don't think that ain't handy! If they ever stop doing that, we'll sure be up that well-known creek without any form of propulsion!

"Anyhow, like I said, the only time you've got to have a schematic is when something's burnt up, like a resistor or a coil and you can't get the identification from it. Although, come to think of it, coils, transformers, yokes and the like ain't too much of a chore. Look here." He dug a catalog from the file. "Here's a catalog put out by Merit that lists all kinds of TV sets and their components, especially yokes, transformers and stuff like that. Sets are listed by make and model number, and it's very little trouble to look up one and find out just what part you need. Thordarson, Sprague, Miller and several others put out similar catalogs. You can get 'em from your parts supply house or direct from the manufacturers. Sure are handy, too!

"Do you know that you can even use these books backward? Instead of looking up the parts from the make and model of the set, you can look up the set from the make and part number of the part!"

"How's that again?" queried the Young Ham. "Run that by slowly, and let me get a better shot at it."

"All right, look. You've got a TV set. You know it's a Silvertone, say, but the model number's been scratched off or something. From the tubes, you've got a reasonable suspicion as to about what year it is, and—"

"How's that, now?" interrupted the Young Ham. "How can you tell from the tubes what year a set was made?"

"Well, you can't, too definitely, but you can get a general idea," admitted the Old-Timer. "Take the 3-volt series. When'd they come out, first? Last year, was it? Anyhow, if the set has 3-volt tubes in it, you know it was made sometime within the last 2 years, on account of they didn't make the tubes until then! Older sets, if they have tubes that haven't been in common use for several years, you know they aren't *newer* than a certain year, and so forth. Oh, just f'rinstance, if you find a 6AC7 in the video output, the set's apt to be over 3 years old because they haven't, as a rule, been using 6AC7's there since about that period. It's just a general hint, that's all."

"I see—I think," admitted the Young Ham.

"Now, where was I? Oh, yes. I was lookin' up sets by part numbers. Yeah. All right. First thing, you take the part numbers off two or three big parts, like the yoke, power transformer, flyback transformer, vertical output transformer and so on. Copy 'em down on a piece of paper, and start lookin' through the catalog for a set, of the right make, which has *all* of those numbers! Chances are, when you find it, it'll be the right one. If it ain't, you can usually get so close that you can use the diagram of that set to find out what you want to know! Why? Because, if it uses all of the same parts, there's bound to be a pretty good similarity between the two sets, see?"

"I think I'm beginning to get a glimmering of the idea," said the Young Ham.

"Well, it's usually a lot of dern trouble, any way you look at it," said the Old-Timer, "but sometimes that's the only way you can get the information you have to have. Guess the only way you could sum it up would be to compare it to a detective, lookin' for clues. You've got to take every little clue you can find. The cabinet, the shape and size of the chassis, the tubes, even the kind of parts, the type of construction used and every little detail. Why, I remember, a long time back, I even identified a radio because one part had a big long part number! Happened to think that the Colonial people had a fancy for great long part numbers, looked one up and there it was! So, if you take advantage of every clue, no matter how small, and add 'em all up right, you come up with the right answer, just like Friday. All you gotta do is get the facts, ma'am."

"Dum-di-dum-dum!" agreed the Young Ham.

"Yes, sir!" said the Old-Timer, leaning back on the bench, "that's gotta be your motto. No fact too small, no clue too insignificant!"

"Well, I can tell you one small insignificant fact you're overlookin' right now," said the Young Ham.

"Huh?"

"There," pointing to the clock. "It's 5 after 6, and I've got a heavy date. We're on overtime right now!"

"Ye Gawds, we can't afford that," cried the Old-Timer, leaping off the bench. "Let's git outa here. My wife's gonna kill me. I told her I'd be home early tonight, too!"

"Down scope, crash dive, all ahead flank," yelled the Young Ham, his voice fading rapidly as he dashed down the hall. " 'Night!" The Old-Timer grinned, pulled the master switch, looked around for cigarettes left burning and ambled after him. END

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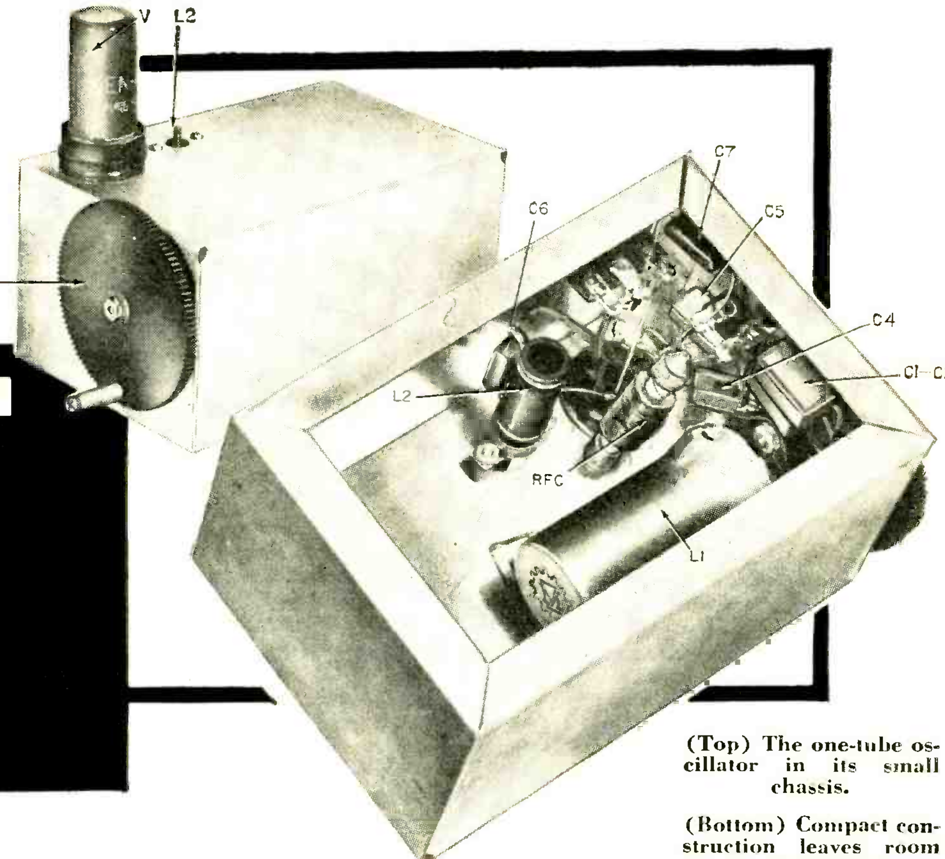
An easy-to-build oscillator without a tuning capacitor

slug-tuned VFO has stable output



(Top) The one-tube oscillator in its small chassis.

(Bottom) Compact construction leaves room for an amplifier stage.

By JACK GALLAGHER, W5HZB

THE difficulties which arise in the construction of a vfo can be reduced by proper choice of circuits. The Clapp oscillator—a very popular circuit because of its stability—is a good choice for a vfo if space is not a major consideration. Although it has good voltage stability, the output varies over the band unless gang tuning is used.

If space is to be considered, a circuit requiring low inductance will make large coils unnecessary. A circuit of this type will require a large amount of capacitance in the form of fixed and variable capacitors and would normally offset the space gained by using a small coil.

A high-C Colpitts oscillator whose frequency is between 1.7 and 2.2 mc, and has a high degree of stability and uniform output over the band is shown in the diagram. To eliminate space-consuming variable capacitors, a slug-tuned coil (L1) is used for frequency variation. A total tank capacitance of some 2,320 μμf is used across the coil in the form of two .001-μf silver mica padding capacitors (C1 and C2) and the series combination of the feedback capacitors of 470 μμf and .001 μf.

Since the Q of a coil for use in a Colpitts circuit can be low compared to the Q required for the Clapp circuit, the Millen type 74001 slug-tuned form is a compact and easily adjusted coil to use with this oscillator.

To keep cost to a minimum, complicated and sometimes troublesome mechanical drive assemblies were rejected. The knob for the unit shown in the photographs was made from a bakelite gear removed from an old tuning capacitor. Since the travel of the slug screw is less than ½ inch, it is easy to make fine adjustments with the tuning knob.

While the 6-40 screw threads on the slug screw provide smooth adjustment and about 40 kc of variation for one revolution of the shaft, almost any variation can be obtained by winding the coil in a different manner.

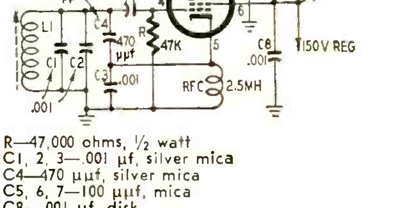
The coil in this unit is wound with 18 turns of No. 20 enamel, spaced in a distance of ⅝ inch. First, the slug was placed at the bottom of the form and the winding started at the top of the slug. The first 9 turns were spaced slightly greater than the wire diameter and the last 9 turns were closewound, ending about ¾ inch below the top of the form.

Although a similar winding method can be used to provide linear bandspread for slug tuning, it was not attempted in this case. The turns were spaced as described merely to cover the frequency range previously mentioned. After the range was checked, the coil was doped sparingly to hold the turns in place.

The construction of the oscillator is simple and straightforward with the exception of mounting the slug-tuned coil. It was mounted as shown in the photographs with a standard octal socket, which clears the aluminum box by ¼ inch, leaving ample room to remove the coil for adjustments. A ⅜-inch hole provides clearance for the slug screw.

The slug-tuned plate coil (L2) is mounted to the right of the 6SJ7 oscillator and is adjusted from the top of the chassis. The slug is set for maximum output. If the oscillator is set at 1950 kc, the output will be almost constant as the tuning is varied from 1.7 to 2.2 mc.

Since the oscillator occupies about half the 4 x 5 x 6-inch chassis, there is room to add a class-A amplifier stage. This will help increase stability when a transmitter is keyed and also provides an ideal keying position. The plate supply of 150 volts should be regulated with a VR150 or an OA2. END



R—47,000 ohms, ½ watt
C1, 2, 3—.001 μf, silver mica
C4—470 μμf, silver mica
C5, 6, 7—100 μμf, mica
C8—.001 μf, disk
L1—18 turns of No. 20 enameled spaced in ⅝ inch (see text)
L2—60 turns of No. 30 enameled closewound on a Millen No. 74001 ½-inch-diameter slug-tuned form
RFC—2.5 mh
V—6SJ7
Chassis—4 x 5 x 6 inches
Knob
Miscellaneous hardware

Circuit of the slug-tuned vfo.

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KNOW YOUR LEVELS

Both low- and high-level amplification have built-in complications. Discover what they are and how to beat them

By NORMAN H. CROWHURST

SOME things about designing or using amplifiers you can find in any textbook. But for some unexplainable reason other items of information that ought to be easy to find seem to get left out. For example, operating levels at various points in an audio system.

The amplifier user needs to know this so he can put the right items of equipment together and get the best performance out of the whole system. The amplifier designer needs this knowledge to select the right components for his amplifier.

A closely related piece of information—that of impedance matching—gets discussed in every second article on amplifiers. So it is common knowledge that a 50-ohm microphone must be connected to a 50-ohm amplifier input. A number of articles have shown how to make resistance pads to match one impedance to another.

I was called in recently on a case which aptly illustrates the lack of this knowledge. My job was to make a microphone–amplifier–loudspeaker combination work. The man who called me had paid careful attention to matching. The microphone was 50 ohms and the amplifier had a 600-ohm input, so he used a line transformer from microphone to amplifier. However, he was unable to get any output from the system.

Examination showed that the amplifier was designed to operate from an input level of 0.5 to 1 volt at 600 ohms. The microphone was one of the higher-sensitivity dynamic types which gives about 3-mv output across 50 ohms for normal speech. The matching transformer from 50 to 600 ohms stepped this voltage up about 3.5 times, delivering a little more than 10 mv to the amplifier. But 10 mv is not enough for an amplifier that needs an input of 0.5 volt (500 millivolts).

"You need more amplification," I told my caller.

"That's easy," he replied, "I have another of these amplifiers here on the shelf, and you know how to make a matching pad so I can work the 16-ohm output of one into the 600-ohm input of the other."

I explained that what he needed was not another power amplifier but a preamplifier for working at low level. This he did not seem to understand. He thought amplification was amplification, and between the two amplifiers there should be enough of it. So I explained briefly why this arrangement would not work.

But how many of us have had to find this out the hard way—by trying it—simply because there was no one on hand to tell us what would happen? Fortunately this job did not prove difficult, because he did have a comparatively high-sensitivity microphone and it wasn't too hard to find a preamp that would work successfully with this power amplifier.

If he had been trying to use a mike with a much lower output level, there would have been bigger problems in finding a satisfactory preamplifier. So let's start at the input end and see what it takes to make a good amplifier that will handle signals at all levels.

Low-level components

When we set out to build an amplifier for amplification at low levels, from insensitive microphones and pickups, particularly the ribbon type, we have to be very careful when selecting components. The first tube gets a *maximum* signal of only a few millivolts at its grid. It is expected to make these signals audible at the output. This is getting down to the level of tube hiss and the hum generated in a good many tubes.

The input circuit must be carefully shielded to avoid hum pickup. This part of the story, though, has been well discussed elsewhere from time to time.

Tube hiss is due to plate current, which consists of electrons flowing from cathode to plate. Each electron transit is a separate event, so the plate current is made up of a random sequence of separate charges passing from cathode to plate. The average rate of transit determines the measured current. When amplifying low-level signals, changes in plate current due to the applied audio grid voltage are not much more than the fluctuation in rate of arrival of electrons at the plate due to the random nature of their departure from the cathode. Therefore, tube hiss is apt to be almost as loud as the audio signal we want to use.

Ways have to be found to minimize tube hiss. The noise a tube generates due to these effects is obviously proportional to the total current flowing—the proportion of fluctuation in electrons arriving at the plate is proportional to the average total number arriving. The noise voltage they develop at the plate is also proportional to the fluctuation in the velocity at which they arrive. The fluctuation in velocity is proportional to the actual velocity

Therefore, halving the *plate current* will approximately halve the noise output of a tube and halving the *plate voltage* will also approximately halve the output. But halving the plate current or plate voltage does not necessarily halve the tube's gain.

Over a wide range of variation in plate current and voltage, a tube's amplification does not vary by too much. Operating the tube with low plate voltage and current gives almost the same amplification as a higher plate voltage and current, but considerably reduces noise introduced by the tube.

From the standpoint of noise, two things are required of an input stage:

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Fig. 2—Matching pad used between preamp and power amplifier permits best operation of overall system. The values suit the example given in the text. For other problems values should be worked out to suit the combination of equipment.

This means that a 12AU7, operated with its two triodes in push-pull, gives distortion and output comparable with a 6SN7, a considerable aid toward miniaturization.

A tube that may look tempting for some purposes is the 12AT7. It gives considerably more gain than either of the others just mentioned and its output is not too much less than theirs. While the 12AT7 has a very acceptable distortion figure at low levels—an input voltage of not more than 0.1—its distortion figures at higher levels do not compare favorably with the other tubes.

I could go on to discuss a whole range of tube types and their relative advantages and best modes of operation. The point I want to stress here is that in the design and use of amplifiers it is important to use the correct type for the purpose.

Other components in the circuit also have different requirements to meet for high-level operation than those at low-level operation. For low-level operation the important feature is reducing noise. At high-level operation the component must be able to handle maximum signal.

A point that can easily be overlooked is the dissipation of resistors. We may determine that a resistor has to drop 100 volts at 20 ma. Its value should be 5,000 ohms. A 4,700-ohm resistor looks like the nearest preferred value for this purpose. How often has the prospective amplifier builder dipped in his box of 4,700-ohm resistors (½-watt rating) and cheerfully put one into his circuit?

Had he stopped to do a little figuring he would have found that 100 volts at 20 milliamps is a dissipation of 2 watts. This would have saved him from finding his voltage-dropping resistor burned out before the amplifier had been in service very long.

So it's a safe rule to check the dissipation of all resistors in high-level circuits. Allow a safe margin, remembering that signals on top of dc potentials *always* increase the resultant dissipation.

There is one more component to consider in high-level circuits—the output transformer. However, designing or selecting an output transformer that will work successfully in a power amplifier is a story in itself. The output transformer is the heart around which a power amplifier is designed. As this is the subject of another article I will not take up space discussing it here.

When putting a system together it is important to know what levels are so you can arrange to minimize both noise and distortion. For example, working a preamplifier into a power amplifier, the power amplifier requires a certain input to give the full power output of which it is capable—usually between 0.5 and 1 volt. The preamp may be capable of giving out as much as 4 or 5 volts before it runs into serious distortion.

If a direct connection is made between these two items of equipment, the gain control of the preamplifier will have to be set between 10 and 20 db below the best operating level. As a result, the input fed to the power amplifier is likely to have more hum and noise than if the amplifier were designed to accept the full output of the preamplifier. The way to get the best performance out of this combination is to insert a resistance pad of the type shown in Fig. 2 so the preamp can deliver its full output of 4 or 5 volts while the power amplifier gets only the output of 0.5 to 1 volt that it needs.

Values can be calculated to suit the particular circuit in hand. Those shown in Fig. 2 suit a preamp with cathode-follower output, working into a power amplifier designed for a 600-ohm input. Although cathode-follower outputs are sometimes advertised as being 600-ohm or similar impedance, they work much better into an impedance higher than this, so it is well to build up the load impedance applied to the output of the preamplifier rather than using the nominal value given.

Use the chart as an aid in calculating the various levels in a system, taking into account impedance changes. To illustrate how it is used, one microphone is listed as giving an output level of −56 dbm for 10 dynes/sq cm, impedance 50 or 50,000 ohms. Another is listed as −59 db referred to 1 volt per microbar. How can we correlate this information?

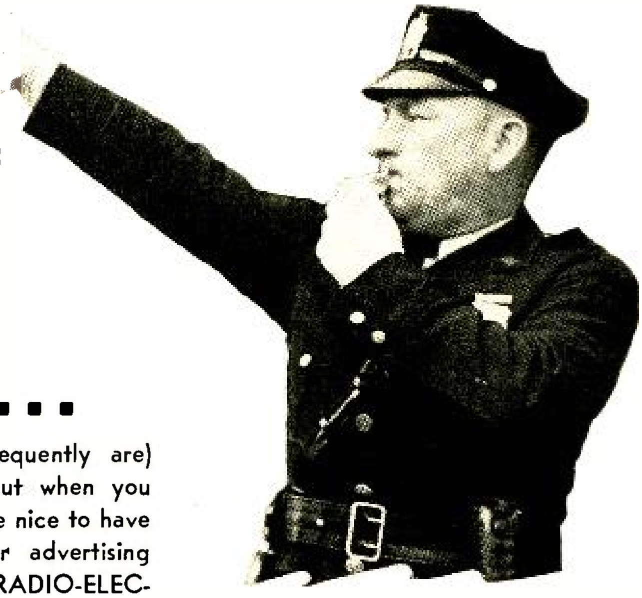
A microbar is the same as a dyne/sq cm, but some people prefer to use one or the other. And 10 microbars or 10 dynes/sq cm represents normal speech level.

The first microphone is listed with a power-level rating for both available impedances. Using the chart, you will find that −56 dbm corresponds to 350-μv at 50 ohms, or −69 db referred to 1 volt. This form of reference is seldom used for low-impedance circuits. For 50,000 ohms, −56 dbm corresponds to 11 mv or −39 db referred to 1 volt.

The second microphone, being only high impedance, uses the voltage reference as being more direct. But it is quoted as −59 db for 1 microbar. Microbars being a unit of acoustic *pressure*, 10 times as many will induce 10 times the voltage. Since −59 db is 1.1 mv, 10 microbars will give 11 mv, or −39 db.

So the ratings mean both microphones have the same output, which we would never have known without this calculation! END

You appreciate him only when you need him...



Cops can be (and frequently are) a pain in the neck. But when you really need one—they're nice to have around. That goes for advertising cops too. Maybe RADIO-ELECTRONICS mail-order tube policy is a nuisance to some people—certainly it is to the "fast buck" operators. But it's good to know it's working for you when you buy tubes by mail. Since January, 1956, the publishers of RADIO-ELECTRONICS have insisted that mail-order tube advertisers state the condition of the tubes they sell —new or used, perfect or seconds, rejects, or surplus. It's no fun to play "cop"—but as long as it saves you from being gypped, we'll keep on doing it.

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NEW DISCS and STEREO TAPES

Reviewed by
CHESTER SANTON
Station WQXR, New York City

LAST month we looked into a special category of tape releases—individually made tapes designed to test the performance of tape machines. In general circulation these days are two other test tapes. These, however, are processed on duplicators: Westminster-Sonotape's 24-minute test extravaganza *Stereophonic Alignment Tape* (SWB-AL 101) at $11.95 and Stereophony's 4-minute *Test Tape for Stereo Balancing* (T-50) at $1.98. Containing more than test tones, both tapes have wide appeal. Playback in each case is 7.5 ips. At that speed, tape response today is reasonably flat to 10,000 cycles. Above that figure, frequency response falls off. For that reason, the Ampex and Livingston test tapes reviewed last month confine themselves to top test tones of 10 kc in the former and 12 kc in the latter.

Sonotape, by "strong-arm" tactics in gain boosting, manages a high-frequency tone labeled "15,000 cps for head alignment." The tone has audible intensity at normal listening level. The test frequencies are followed by an elaborate series of tests for balancing volume and equalization in the two channels. Perhaps the most useful of these is an excerpt from *Peter and the Wolf*. The music is switched several times from one channel to the other. With equalization controls of each channel in a flat position, this test is a good reference if further adjustments are necessary in the bass and treble setting on either channel. All told, the Westminster tape is quite a production. As a grand finale, the sounds of a subway train are merged with Tchaikovsky's *Fourth Symphony*.

The Stereophony tape performs its function without fuss or frill. Test tones of 3,000 cycles are alternately heard on each channel. The process is then repeated with tones of 100 cycles. In the final episode, the narrator moves from one microphone to the other. If the channels are in balance, he comes to a halt at a point midway between the two speakers.

If your system has separate volume controls, even the simplest tape for alternate-channel balancing can be useful in locating the "center of gravity" of the sound suspended between the speakers. Once located, its value is obvious, especially in the opening measures of classical music where one side of the orchestra provides most of the sound.

Stereophonic Recordings

Now that the stereo record is on the market, experiment in this medium has reached the consumer level. Audio Fidelity made this possible with its release in March of four Stereodiscs: *Dukes of Dixieland* (1851), *Railroad Sounds* (1843), *Music of the Bullring* (1835) and *Johnny Puleo and His Harmonica Gang* (1830)—all priced at $6.95. Played with the Electro-Voice ceramic stereo cartridge, these records exhibit reasonable stereo effect when the recommended distance of 6 to 8 feet separates the loudspeakers. The audio quality is passable. In my opinion, cleaner sound was present on the first truly compatible stereo disc demonstrated by Columbia Records during the recent IRE convention. As in stereo records, the commercial releases will tell a more complete story.

Walter Schumann presents the Voices
RCA-Victor Stereo Tape APS-103
(7-inch; playing time, 15 min. $6.95)

This tape offers very realistic projection of solo voices from within a highly trained mixed chorus. The acoustics of the recording studio are exceptionally "live." This liveness aids greatly in shifting the apparent sound source from the speakers to the area between them. This phenomenon remains the first sign of true stereo. Of the five tunes on the tape, *Blue Tango* and *Would You Like to Take A Walk* get outstanding treatment.

VIENNA
Fritz Reiner conducting Chicago Symphony Orchestra
RCA-Victor Stereo Tape ACS-63
(7-inch; playing time, 15 min. $6.95)

In stereo, RCA bows to no one in the concert waltz. Between them, the Chicago under Reiner and Fiedler's Boston Pops have taken over the field. Johann Strauss' *Morning Papers* and *Village Swallows* by Joseph Strauss are heard in excellent dynamic range that lends weight to the percussion without introducing distortion. With a proper stereo setup, the swallows are truly airborne.

TCHAIKOVSKY: *Symphony No. 5*
Herbert Albert conducting Mannheim National Symphony
Livingston Stereo Tape 4001 K
(7-inch; playing time, 48 min. $17.95)

The first Tchaikovsky *Fifth* to appear on stereo tape. Exceptional sonority and warmth in the woodwinds highlight a relaxed performance. The intimate miking in stereo explores, in a new way, the moody content of this music. It also reduces the already low tape hiss.

A Miracle in Sound
Mercury Stereo Demonstration Tape DEMS-2
(7-inch; playing time, 15 min. $5.95)

A recent cross-section of the Mercury catalog. The 10 stereo excerpts range from calypso to classics. The equalization is not the same on all samples. On expensive systems, the *Gaîté Parisienne* excerpt reveals exaggeration in the highs.

Dance Atop Nob Hill
Ernie Heckscher and His Orchestra
Verve Stereo Tape VST-10009
(7-inch; playing time, 31 min. $12.95)

Verve presents 25 ultra-danceable favorites in clean, bright sound—effervescence without the hiss. The recording technique matches the brisk style of Ernie Heckscher's orchestra—a fixture at San Francisco's Fairmont Hotel for the past 10 years. Well-centered stereo will add a new dimension to your next party.

The Big Reunion
Fletcher Henderson All Stars in Hi-Fi
Concert Hall Stereo Tape DX-71
(7-inch; playing time, 12 min. $6.95)

Memories of one of the first large jazz bands revived in today's sound. The Great South Bay Jazz Festival of 1957 brought together a number of the alumni of the Fletcher Henderson band. This inspired recording, made a few weeks later, puts stereo to good use. Wonderful definition in the ensemble work in the classic *King Porter Stomp* with the brasses appearing several feet above and beyond the sax section. The disc version (Jazztone J-1285) offers far more music in equally straight-forward sound.

Modern Orchestral Textures
Willis Page conducting New Orchestral Society of Boston
Cook Stereo Tape 1068
(7-inch; playing time, 19 min. $12.95)

Audiophiles familiar with the *Pacific 231* performance on 10-inch LP will welcome the same Cook version on stereo tape. Honegger's orchestral portrayal of a locomotive demands a spatial medium for full impact. The miking, unusually distant, dictates a moderate volume setting to stay below the noise level of that day. The tape includes Debussy's short, atmospheric *Danse* and a performance of Barber's *Adagio for Strings*, which I prefer to most other recorded versions.

Monaural Recordings

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

BEETHOVEN: *Piano Concerto No. 5 in E Flat (Emperor)*
Rudolf Firkusny, Pianist
William Steinberg conducting Pittsburgh Symphony Orchestra
Capitol PAO 8419

Capitol's time-tested miking formula for the Pittsburgh hall contains a recent refinement. According to Frank Abbey, chief recording engineer at their sessions, the single Telefunken located in the first row of the concert hall's second balcony remains the basic microphone for overall pickup. All of the Pittsburgh recordings have utilized it. On stage, however, three Telefunkens have now replaced the ribbon mikes formerly used for solo passages in the orchestra. An extra Telefunken picked up the piano. The result—a true concert hall balance. The performance of Beethoven's greatest piano concerto is an excellent one.

London Microgroove Frequency Test Record
London FFRR 5343

London's new test recording is based on the RIAA curve. Its 25 tones range from 30 to 18,000 cycles. The separate frequency bands are arranged in groups of five. Frequencies above 10 kc are recorded 6 db below standard curve. Side 2 contains gliding frequencies with the same range and levels.

Espana, Vol. 9
Ataulfo Argenta conducting Orquesta de Camera de Madrid
London FFRR LL-1740

Orchestral interludes from the Spanish lyric theatre directed with smooth authority by the late Ataulfo Argenta. London's latest recording in *The Music of Spain* series enhances the reputation for sound established in previous volumes. This disc holds its richness of sound at all levels. A deluxe item.

Bagpipes and Drums
9th Regiment, New York State Guard Pipe Band
Audio Fidelity AFLP 1857

Giant Wurlitzer Pipe Organ
Leon Berry, Organist
Audio Fidelity AFLP 1844

On a good system, the low bass on these two records will jar loose the fillings in your teeth, so close is the pickup. Audio Fidelity has added to its microphone roster the Electro-Voice 667 with transistorized features. Their closest miking to date does away with virtually all room acoustics. To reinstate some of them, try listening to these in an adjoining room. Traditional bagpipe music on the first record. The second offers rumpus-room fare on the Wurlitzer that Leon Berry has installed in the basement of his home. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*

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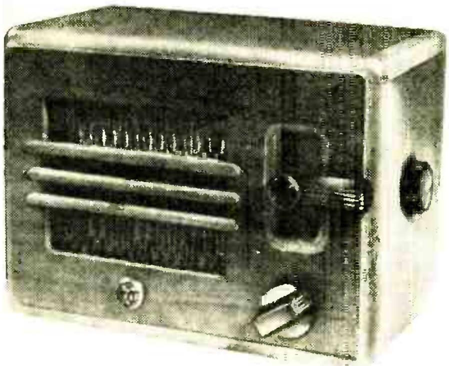


Remote Transistor Ear

This 3-transistor intercom has a ½-watt output

By F. J. BAUER, JR., W6FPO

NOW that low-priced power transistors are generally available, you can build transistor equipment with power output equal to that obtainable with vacuum tubes. The intercom described in this article is an all-transistor device which plugs into the 117-volt ac power line. It has an audio output of approximately 1 watt which is instantly available as no warmup time is required.

There are three transistor audio stages, and a selenium bridge rectifier for the power supply. The circuit is simple and conventional except for the input stage, which is connected as a common-base amplifier. This configuration does not require an input transformer since its input impedance is low enough to work directly as speaker voice-coil impedances. Eliminating the input transformer also reduces the possibility of hum pickup by the input stage and results in a quiet, high-gain amplifier. The .015-μf ceramic disc capacitor connected across the amplifier's input eliminates broadcast-station interference when the intercom is used with a long remote-speaker line. The rest of the amplifier circuit is straightforward, employing transformer-coupled common-emitter stages.

All parts are standard and readily available, with the possible exception of output transformer T3. I used an Acme Electric Corp. T-24041. If you cannot obtain this unit, you can use a Thordarson TR-61. The primary's ct is not used and only the 3.2-ohm tap on the secondary is shown in the diagram. The power transformer is a 6.3-volt heater transformer with a 1-ampere rating.

No attempt was made to miniaturize the unit. Plenty of room was available for standard components on the 6½ x 4-inch chassis. Standard components also reduce the cost of parts.

The 2N255 power transistor is plugged into a nine-pin miniature tube socket with no heat sink for the collector. Its case must be insulated from the chassis. A heat sink is not required because the power input to the 2N255 is limited to 1.25 watts, or half the transistor's maximum dissipation rating.

Hints for better construction

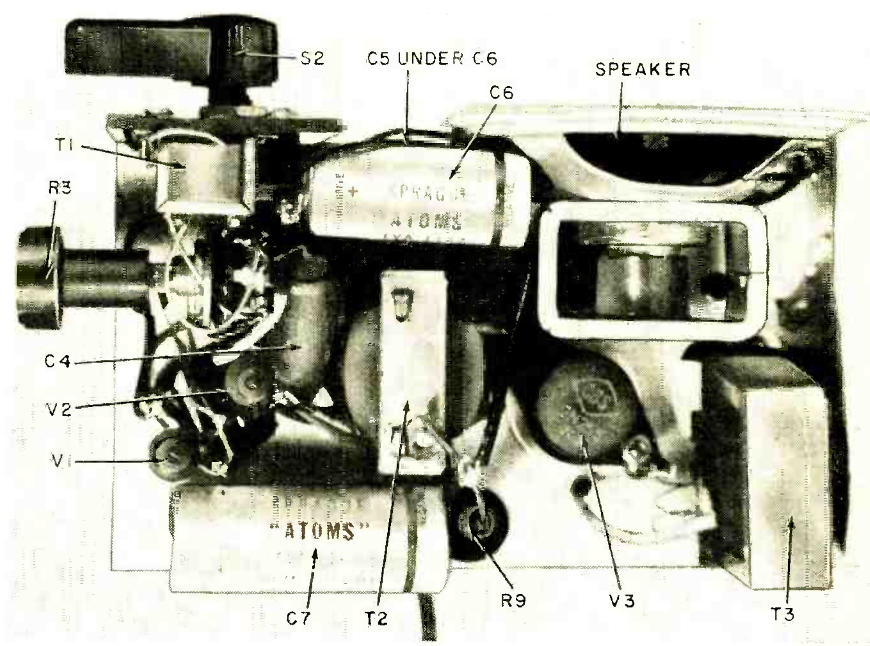
The parts layout is not particularly critical. In general, the amplifier follows a logical layout from left to right when viewed from the rear, with low-level components such as the small transistors and interstage transformers mounted at the left end. The output transformer, power transistor and selenium rectifier are mounted at the right end of the chassis, as shown in the photographs. When laying out the amplifier, pay particular attention to the following items to avoid possible feedback troubles:

A ½-inch separation between the speaker frame and output transformer core is minimal, as shown in the photographs. If the transformer is too close to the speaker, you'll get audio feedback when the intercom speaker is used as a microphone.

The output transformer's secondary leads must be routed well away from the speaker, preferably below the chassis to prevent feedback. Shield this lead and ground it to the chassis.

Do not mount the power transformer on the chassis. The field from the transformer will induce a 60-cycle hum in the speaker when it is used as a microphone, no matter where the transformer is placed on the chassis.

This problem is solved by completely isolating the transformer from the intercom. The transformer is mounted in a small metal box which plugs directly into the ac outlet. The ac line running



Top view of the completed intercom. The remote speaker connects to terminals on the rear of the unit.

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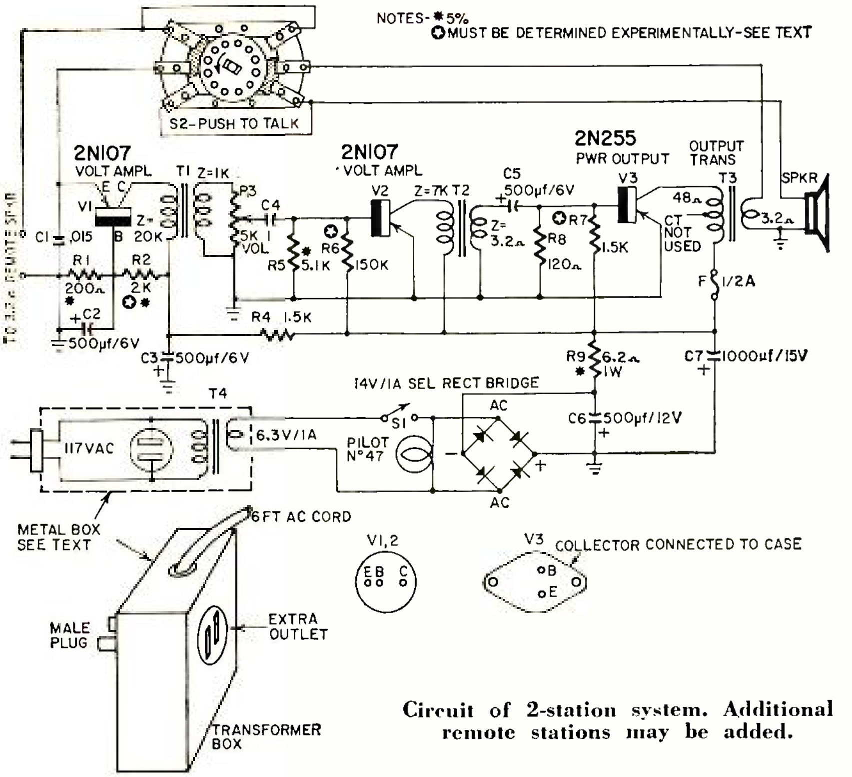


Circuit of 2-station system. Additional remote stations may be added.

R1—200 ohms, 5%
*R2—2,000 ohms 5%
R3—pot, 5,000 ohms, audio taper
R4—1,500 ohms
R5—5,100 ohms, 5%
*R6—150,000 ohms
*R7—1,500 ohms
R8—120 ohms
R9—6.2 ohms, 1 watt
All resistors ½-watt 10% unless noted
**Values shown for these resistors are the ones used by the author. However, the proper values for your unit must be determined experimentally. See text for details*
C1—.015 μf, disc ceramic
C2, 3, 5—500 μf, 6 volts, electrolytics
C4—1 μf, metallized paper
C6—500 μf, 12 volts, electrolytic
C7—1,000 μf, 15 volts, electrolytic
F—0.5-amp fuse
RECT—selenium-bridge rectifier, 14 volts dc, 1 amp (Barry Electronics Corp., 512 Broadway, New York 12, N.Y.)
S1—spst
S2—dpdt, spring-return wafer type (Centralab 1464 or equivalent)
T1—interstage transformer: primary, 20,000 ohms; secondary, 1,000 ohms (Argonne AR-104 or equivalent)
T2—output transformer for 50L6 or 50C5. Primary impedance 7,000 ohms; secondary impedance 3.2 ohms
T3—output transmormer: primary impedance 48 ohms, ct not used; secondary impedance 3.2/8/16 ohms (Thordarson TR-61 or equivalent)
T4—heater transformer: primary, 117 volts; secondary, 6.3 volts, 1 amp (Thordarson 21F08 or equivalent)
Speakers, 3.2-ohm; 3-, 4- or 5-inch
Fuse holder
Pilot-lamp assembly and No. 47 bulb
Chassis, 6½ x 4 inches
Cabinet, 6½ x 5½ x 4 inches
Transformer box, 4 x 2⅛ x 1⅝ inches
Male plug
Miscellaneous hardware

from the transformer box to the intercom unit carries 6 volts. During operation, the remote power transformer is left on continuously and the intercom switch is used to turn the unit on and off. The switch merely opens a lead to the bridge rectifier. This arrangement is practical since the transformer draws negligible power from the line, especially with the intercom switch in the off position.

I mounted some of the electrolytic capacitors above the chassis since they are bulky and chassis space is available. The capacitor leads are covered with insulating tubing and routed through holes in the chassis as required.

Selecting the bias resistors

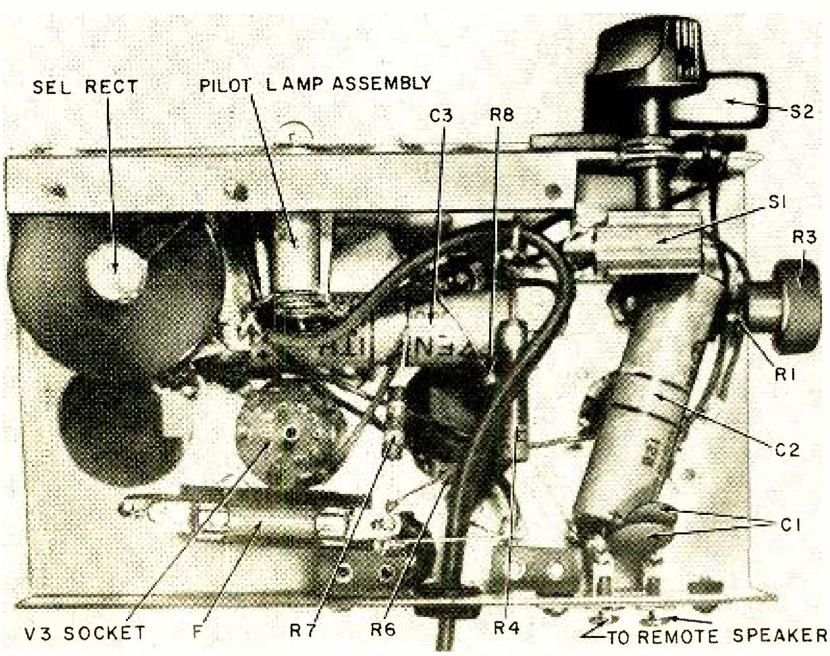
The unit should be completely wired except for the base bias resistors (R2, 6 and 7) and the push-to-talk switch (S2). Connect the intercom speaker to the output transformer temporarily and connect a remote speaker to the amplifier input. Be sure the remote speaker is placed so it does not cause acoustic feedback. Connect a 500-ma meter across the fuse holder with no fuse installed. The amplifier is now ready for bias adjustments of the various stages.

Connect a 5,000-ohm potentiometer in the circuit for R7 and make certain that the full potentiometer resistance is in the circuit before the power is turned on. Adjust the potentiometer for a collector current of 250 ma. Allow the 2N255 power transistor to reach full operating temperature by letting it run for about 20 minutes, meanwhile readjusting the potentiometer to keep the collector current at 250 ma. When the output stage has stabilized, as evidenced by no further change in collector current, check the potentiometer's resistance on an ohmmeter and install the nearest standard-value resistor permanently. Now check the collector current with the resistor installed and, if all is well, you can disconnect the milliammeter and put the 0.5-amp fuse in its holder.

Follow the same procedure to determine the proper bias resistor for the driver stage, starting with approximately 300,000 ohms for R6. Adjust the 2N107's collector current to 1 ma and again allow sufficient time for the stage to stabilize with respect to collector current.

If collector current cannot be limited to 1 ma, the 2N107 transistor should be replaced with another. Some experimental transistors, such as the 2N107, have a tendency to draw excessive current even with zero bias when operated near maximum ratings of 5 volts or so, due to the lack of uniformity in these low-priced units. Such transistors will still perform satisfactorily in low-level low-voltage applications.

When adjusting the bias of the common-base amplifier stage, use a 5,000-ohm potentiometer to determine the value of R2. You will find that the base voltage adjustment for a given tran-



Parts layout under the chassis.

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sistor is fairly critical. Low emitter-base voltage will result in low collector current and noise with low amplification.

As the emitter-base voltage is increased, the thermal noise heard in the speaker is gradually reduced and amplification increases noticeably. If the bias adjustment is carried too far, the useful amplification will drop and the amplifier will cease to function. The proper adjustment for maximum gain is just below that point. I find that the easiest way to make this bias adjustment is to place the remote test speaker in a quiet location and use the ticking of an alarm clock as the signal source.

After adjusting the bias on the various stages and checking the amplifier for stability, wire in the PUSH-TO-TALK switch. If the amplifier tends to oscillate on talk-back, reroute the output transformer lead to minimize feedback. Careful routing of the output transformer's output lead is very important.

The routing of this lead is particularly critical where it connects to the push-to-talk switch, since it is close to the amplifier input at this point. The best procedure is to shield the lead and move it around until there is no feedback on talk-back with gain nearly wide open. During this test be sure that the remote speaker is far enough from the master unit so you will not be fooled by a case of acoustic feedback.

Most of the time electrical feedback cannot be completely eliminated with the gain wide open on talk-back.

Final steps

It will probably be necessary to treat the cone of the intercom speaker. If the speaker size is less than 5 inches, it tends to produce distortion, when used as a microphone because of the thinner cone material used in such a small unit. If distortion is experienced on talk-back, give the speaker cone two coats of shellac to increase the diaphragm stiffness. Shellac the flat conical section only and leave the ribbed outer section near the frame untouched. This will give you a relatively stiff diaphragm with a flexible suspension. This way, performance as a microphone is greatly improved without impairing its performance as a loudspeaker.

No station-selector switching system was built into the unit because this feature was not desired. However, a regular station-switching system may be added if you want more than one remote station.

If excessive thermal hiss develops after the intercom has been in service for a while, it is an indication that the first stage has changed characteristics due to transistor aging. This may be corrected by determining a new value for bias resistor R2. Low-noise transistors are now available, so if you feel that the residual amplifier noise is objectionable, after bias adjustment, try a 2N106 or 2N189 in place of the 2N107. END

a PA DUMMY LOAD

Lets you test your amplifier without raising the roof

By RICHARD H. HOUSTON

IN PA work, particularly on jobs other than the run-of-the-mill type, a dummy load is helpful. The amplifier builder finds a dummy load handy for testing purposes. An actual setup we used recently is an example. The job called for recorded music and live program material to be "broadcast" from the park in which the community Christmas tree had been set up. Since the programs were to continue during the entire Christmas season, I decided to establish a temporary studio in my home. The park was several hundred feet from the studio, making a volume indicator and aural monitor necessary. The wide variety of live program material presented the problem of auditioning each "act" in advance to determine correct microphone placement, gain settings, etc. A dummy load resistor to replace the speaker line solved the problem since the volume indicator, monitor, PA amplifier and other equipment operated just as though the speakers were connected.

When a dummy load is needed, the PA operator can connect an appropriate resistor across the amplifier's output, but this necessitates a certain amount of haywire and does not lend itself to rapid switching from load to speakers as is sometimes necessary. A far smoother program and a better impression on the customer will result if a neat, easily installed, quickly operated dummy load box is used.

Such a load box, capable of absorbing 40 watts of audio power, is shown in the photos and Fig. 1. Switch S2 connects either the speakers or the dummy load to the amplifier output. Switch S1 selects the load impedance to match the amplifier and speakers. Connections to the amplifier and speakers are made through sockets on the rear of the cabinet or a terminal strip mounted above the sockets.

Building the load box

Construction of the load box is simple. The entire unit is contained in a 6 x 6 x 6-inch steel box with removable panels at the top and bottom. Input J1 has a separate terminal for each common PA output impedance. Each of these terminals is connected to a corresponding terminal on S1-a. When S2 is in the SPKR position, the rotor of S1-a is connected to the rotor of S1-c. When S2 is thrown to the LOAD position, the rotor of S1-a connects to the rotor of S1-b, which selects a dummy load resistor to match the amplifier impedance.

The impedances available are 2, 4, 8, 15, 200 and 500 ohms. Other values may be used if these do not match the speakers or amplifiers you use. The load resistances are made up of combinations of individual resistors in series and parallel. If single resistors of the desired resistance and power rating could be obtained the construction would be simplified, but some values are very difficult to find. However, it is not difficult to make up any required value from standard units. A more refined unit built with noninductive resistors would enable the experimenter to make precise measurements of output, distortion and other factors. For most PA purposes, ordinary wirewound resistors are adequate.

I made up the load resistances from my junkbox (Fig. 2). Four 500-ohm 10-watt resistors in series-parallel form the 500-ohm load. Two 400-ohm 20-watt units in parallel make up the 200-ohm load. The 15-ohm load is made from four 15-ohm 10-watt resistors in series-parallel.

The 8-ohm load is a combination of five 10-watt resistors in parallel (obviously a junkbox combination). I used 33-, 39-, 40-, 44- and 50-ohm resistors. Their actual resistance is 8.1 ohms, but this difference is negligible. The 4-ohm load is four 1-ohm 20-watt resistors in series with a tap to form the 2-ohm load. Each combination of resistors is secured to the rear wall of the cabinet by a threaded rod passed through the hollow core of two of the resistors.

It is a fairly simple matter to make up the required combinations of resistors from a well-stocked junkbox or from manufacturer's stock. The resist-

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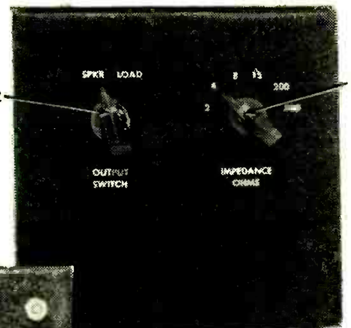
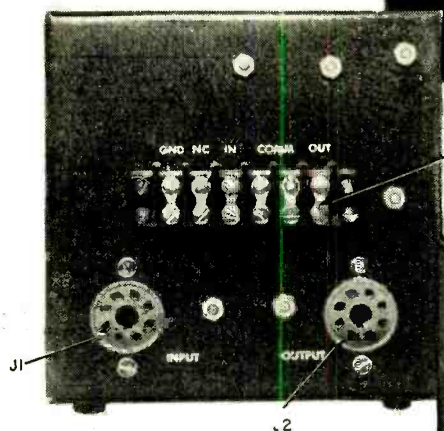
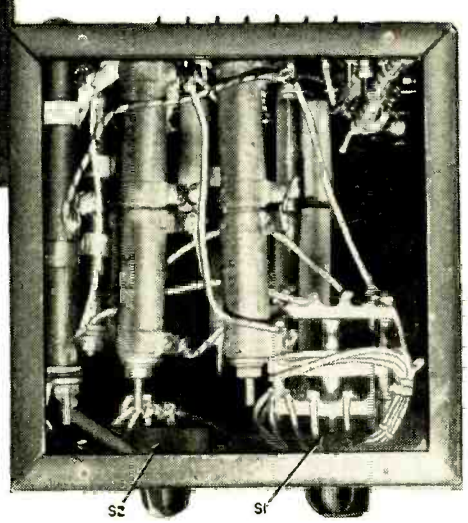


(Right) The PA load box has only two controls.



(Below) Input and output connections are on rear of cabinet.



(Below) Load resistors are fastened to rear of case.

R1—500 ohms
R2—200 ohms
R3—15 ohms
R4—8 ohms
R5, 6—2 ohms
All resistors 40 watts or more, wirewound. See text
J1, 2—octal sockets
S1—3-pole 6-position rotary
S2—spdt rotary
Terminal strip, 5 or more contacts (1)
Cabinet, 6 x 6 x 6 inches
Knobs
Miscellaneous hardware

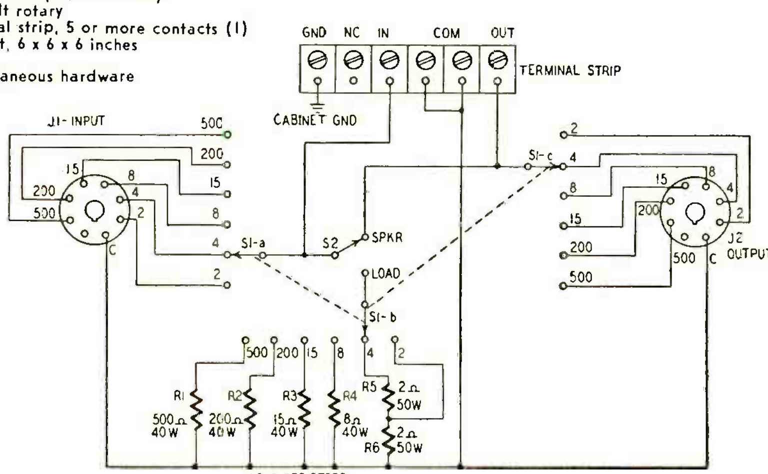


Fig. 1—Circuit of the PA dummy load.

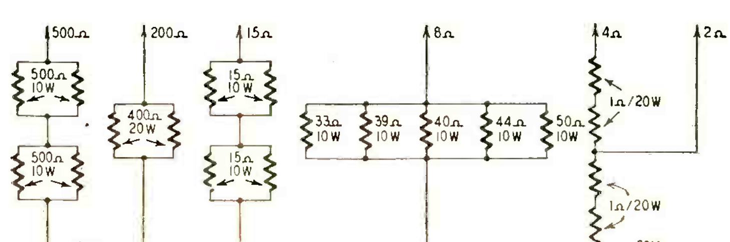


Fig. 2—Author used this method to obtain proper load impedances.

ance of a combination is calculated with the usual parallel- and series-resistor formulas. Keep a sharp eye on the wattage ratings to see that the total rating of the combination will equal or exceed the desired rating, which was 40 watts for this equipment. If identical resistors are used in series, in parallel or in a *symmetrical* series-parallel arrangement (as in the 500- and 15-ohm loads), the total wattage is the sum of the individual wattages. If dissimilar resistances are connected in any way or identical resistors are connected in a nonsymmetrical circuit (one resistor in series with a parallel combination of two others), the total wattage is a bit more difficult to calculate.

Wattage calculations

The easiest way to calculate the wattage of a circuit is to figure on the basis of the voltage across a parallel circuit or the current through a series circuit. For example, the 10-watt resistors used for the 8-ohm load are all in parallel, and the total power is easily calculated on a voltage basis. Since power is equal to E^2/R and the same voltage must of course appear across all resistors in a parallel combination, the lowest resistance unit will dissipate more power than any of the rest. In our case, the voltage is limited to that which will cause the 33-ohm resistor to dissipate its full 10 watts. This 10 watts equals $E^2/33$, so E, the maximum permissible voltage, is 18.2. This voltage across the entire combination, whose combined resistance is 8.1 ohms, corresponds to a total power rating of $(18.2)^2/8.1$, or 40.7 watts.

(Compare catalogs of various resistor manufacturers. Available resistances and wattages vary in different lines. It is possible to obtain all resistors except R4 in single units of either 40 or 50 watts, depending on the brand. R4 can be a series combination of 3 and 5 ohms or 4 and 4 ohms, each at 25 watts, or a parallel network of two 15-ohm 20-watt units. The selection depends on the brand or brands handled by your dealer.—*Editor*)

The input and output jacks are ordinary octal sockets since these connectors are standard in my equipment. Other types of connectors can be substituted to match any system. In any unusual or experimental situation where standard plug connections are inadequate, lines connected to the terminal board may be switched in exactly the same way as cables connected through the plugs. The SPKR–LOAD switch is a rotary switch, since switching may be necessary when silence must be maintained.

Probably few PA men have provided dummy loads for their work, but for the unusual job the convenience is well worth the effort of construction. Within a short time a flexible, easily used dummy load box will become an indispensable part of PA gear. END

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TAKE YOUR PICK: CHANGER or TURNTABLE

Some like changers, others prefer turntables—an outstanding one in each category is described here: the Glaser-Steers GS-77 changer and the Weathers ML-1 turntable

By HERMAN BURSTEIN

WHILE a transcription turntable is preferred for the utmost in high fidelity, the better record changers manage to keep only a step behind in performance. This step is so short that for many audiophiles the difference between a turntable and record changer is insignificant. Considering the numerous operating conveniences that changers offer and their generally lower price compared with a transcription turntable plus tone arm, it is easy to understand why changers are popular in high-fidelity systems.

Glaser-Steers GS-77

The Glaser-Steers GS-77 record changer is a newcomer that incorporates several novel and important features together with those that have become standard for changers in general. Despite its many features, the mechanism is relatively simple, as changers go, which is important from the viewpoints of reliability and ease of servicing.

The most striking innovation is the automatic speed change made possible when the speed-selector knob is in the Speed Minder position. Then 10- and 12-inch 33⅓-rpm records can be intermixed with 45-rpm records, and the machine will change automatically from one speed to the other as necessary. The index finger (see photos) contacts each record to gauge its size and adjust the starting point of the pickup arm accordingly. The finger cannot contact a 7-inch 45-rpm disc. This actuates the speed-change mechanism. The automatic speed-change and intermix feature does not extend to the 16-rpm speed. The speed knob must be turned to the 16-rpm position.

Although 33⅓- and 78-rpm records cannot be intermixed with an automatic speed change, the GS-77 in Speed Minder position shifts automatically to 78 rpm when a modified G-E VR-II cartridge, optionally available with the changer, has its 78-rpm stylus brought into position. A small arm on the cartridge strikes a lever on the rest post and causes the shift to 78 rpm. Piezoelectric cartridges frequently use a flipover arm for changing from microgroove to standard stylus, and in some cases this arm can serve the same purpose as the special arm on the G-E. Glaser-Steers reports that a number of manufacturers of cartridges with dual styli are modifying them to incorporate such an arm. For cartridges without a flipover arm or with a specially attached one, the GS-77 comes with a clip which is mounted on the pickup arm to actuate the 78-rpm lever on the rest post.

The automatic change to 78 rpm, accomplished by changing from microgroove to standard stylus on a turnover cartridge, is not merely a convenience but also a matter of record safety. Many users of turnover cartridges have had the sad experience of accidentally playing a microgroove record with a 3-mil stylus and damaging the grooves. The automatic change to 78 rpm when the 3-mil stylus is brought into position provides an immediate alarm—Donald Duck sound—if a 33⅓-rpm disc is played.

The change cycle is very brief, about 5 seconds, and remains the same at all four speeds as the change mechanism is independently driven by the motor rather than the turntable. During the cycle the turntable is stopped—by a brake against the inner rim—to prevent possible record abrasion as one disc drops onto another and so that the stylus will not cut across a moving groove as the arm comes down. Turntable motion resumes only after the stylus is in the lead-in groove, and full speed is reached in a fraction of a revolution.

For correct operation, three adjustments are readily accessible to the user at the pickup arm. One, to vary stylus tracking force; another to index the pickup arm so it will start at the proper point on the record, and the third to adjust the height at which the stylus stops above the turntable.

The tracking force remains within 1 gram from bottom to top of a stack of records. This is done by mounting the counter-tension spring of the arm as nearly horizontal as possible, so its length changes very little as the pickup arm moves up and down.

Resonance of the tone arm, always a problem and more so in changers, is kept below 20 cycles by using an aluminum casting with reinforced ribbing, having no parallel surfaces and isolated from the deck by a rubber bushing.

The GS-77 can be operated manually if desired, and by placing the balance arm over the spindle the changer will shut off automatically when the record is over. The tripping mechanism that actuates the change cycle does not operate until the pickup arm reaches the last few grooves, so premature tripping due to cuing or groove irregularities is much less likely to occur. If the pickup arm is moved during a change cycle, the mechanism will not be damaged—frequently a bugaboo in record changers. The idler wheel, which drives the turntable rim, is automatically disengaged from both the motor pulley and turntable rim when the changer shuts off, preventing wow due to deformation of the rubber on the idler. Sound output is muted during the change cycle and when the tone arm is on the rest post. An R-C filter across the motor switch prevents a disturbing pop in the speaker when the changer shuts off.

In addition to quality of design, parts and assembly, performance of a product depends vitally upon adequate testing. After alignment and inspection for correct operation, *every* changer is checked for conformance with the following requirements: flutter (above 20 cycles) no more than 0.1% rms; wow (below 20 cycles) no more than 0.25% rms; rumble equivalent to at least 40 db below a 500-cycle signal recorded at 7 cm/sec peak (NARTB specifies rumble to be 35 db down); speed accurate within 2%. The inspected units are placed in racks of eight, and three of these eight are checked over again. If one of these three fails to meet standards, all eight undergo a complete check.

Weathers ML-1 turntable

The Weathers ML-1 turntable follows a design philosophy quite contrary to other professional units, yet comes up with truly professional specifications—wow 0.1%, flutter .01%, rumble 70 db below a recorded level of 7 cm/

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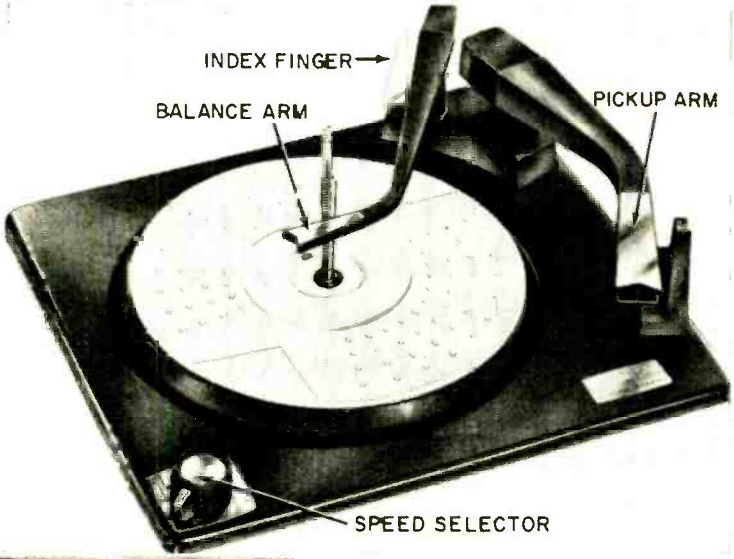
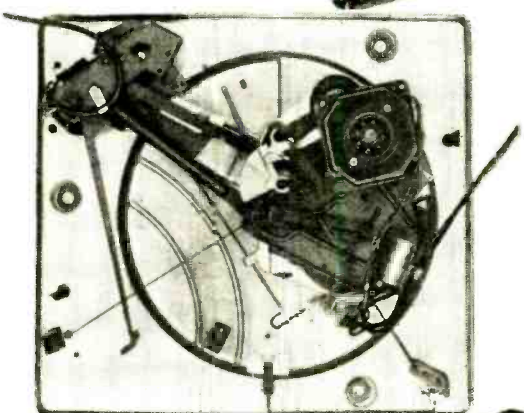
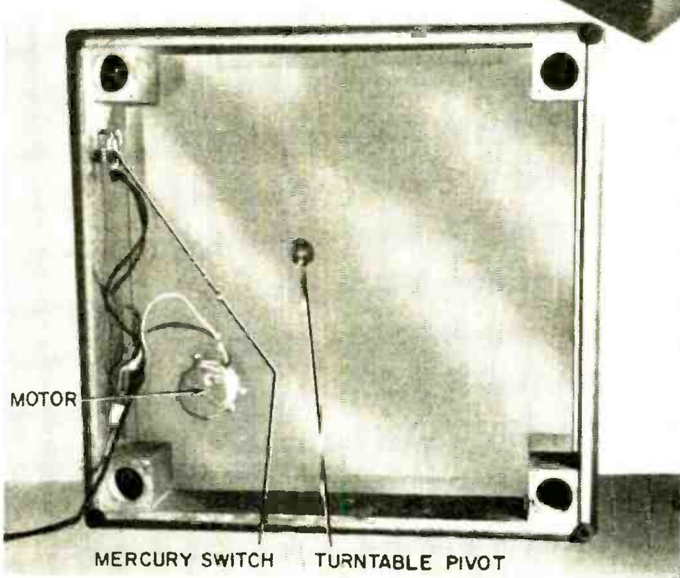


The Glaser - Steers GS-77 ready to use.



A bottom view shows the comparative mechanical simplicity of the GS-77 changer.

The Weathers ML-1 turntable. The firm's FM capacitance pickup is shown.



The diminutive motor mounted under the motorboard presents an unusual appearance to the audiophile and represents a new approach to professional type turntables.

sec, and speed accurate within 0.25%.

The basic problems of a turntable are rumble, flutter and wow, which originate in motor vibration. Mr Charles J. Gillies, a Weathers engineer, points out in a letter he wrote me that the vibration causes the rumble, while flutter and wow are due to shock-mounting of the motor and to the speed-reducing idler wheel used in many turntables.

In his words, the Weathers design philosophy is: "Why not use a very small precise motor which is practically free of vibration? This is exactly what we have done. The motor is a 12-pole synchronous type which rotates at only 600 rpm. It is so free of vibration that we can mount it solidly on the motor board. . . . The turntable can be driven directly from the shaft of the motor by a small rubber wheel of special shape which is made of very live pure gum rubber.* The bearing system is extremely free, and the platter itself is very light. Since the motor is very free of vibration, it is not necessary to use excessive weight to damp out the rumble."

Synchronous motors are known to have a tendency to hunt about their nominal speed and, partly for this reason, heavy turntables are used to provide a steadying flywheel action. How does the Weathers unit get around the hunting problem despite use of a table weighing less than a pound?

Mr. Gillies replies: "Many manufacturers defeat some of the truly fine features of a synchronous motor by making it much too big. When the armature is heavy, it takes considerable power to turn it at this speed and there always is a tendency to hunt around the correct speed, due to the moving part of the motor. Our tiny motor has so little mass that this effect is mitigated. Also . . . you still get flywheel action from our turntable since its mass in relationship to motor mass is large. . . . The Weathers turntable will come from a dead stop to synchronous speed in three-quarters of a revolution and will not go beyond this synchronous speed. Thus, the hunting of the entire turntable as well as the hunting of the motor have been eliminated."

It is interesting to note that the ML-1 comes complete with base, and that resonance of the suspension system between turntable and base is kept low enough to minimize the effects of floor vibration, often a serious problem when the cartridge is operated with very low tracking force. The turntable pad is designed to suspend the record only at the outer rim, and a plastic disc around the center post supports the center, thereby preventing contact with the playing surface and resulting abrasion, pickup of dirt, etc. Although the ML-1 operates only at $33\frac{1}{3}$ rpm, an electronic control is optionally available to drive it at the other speeds in common use. END

* To isolate such little vibration as does exist.

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more jobs for SEMICONDUCTORS

Part II—They measure heat and light . . . make heat and light batteries . . . air-condition and refrigerate without moving parts

By PAUL PENFIELD, JR.

LAST month we saw how semiconductors could be used as voltage-variable capacitors and electronic switches or to measure magnetic fields. Now we will go on to photoresistors, photodiodes, photocells, thermistors and thermocouples.

Photosensitive devices

Many kinds of photosensitive semiconductor devices are possible. There are photoresistors, photodiodes, photovoltaic cells, phototransistors, PME photocells and lateral photocells.

The effect of light on a semiconductor is easy to understand. As you may know, light comes in small packets or photons. Each photon that hits a semiconductor makes an electron jump across the forbidden band—that is, it simultaneously creates an electron and a hole. Practical photocells use these electrons and holes.

Photoresistors are merely pieces of semiconductor, with two leads attached as in Fig. 5. A voltage is applied across the sample but only a small amount of current flows, since the number of holes and electrons available for conduction is small in a semiconductor. As soon as the photoresistor is exposed to light more electrons and holes are available and much more current flows.

Practical photoresistors can be extremely small. The recent cadmium sulfide and lead sulfide photocells are actually photoresistors. Germanium and silicon can also be used.

Another device is the photodiode. This is nothing more or less than an ordinary diode—either point-contact or junction. In operation it is reverse-biased, so very little current flows. But when the junction is illuminated, hole-electron pairs are formed. These pairs flow, forming current. Very high efficiencies are possible, and the photodiode is a widely used device.

You can get the same effect using ordinary diodes, but with less efficiency. Try it yourself on one of the diodes that come in a glass case. The circuit of Fig. 6 demonstrates this principle. Be careful about battery and diode polarity, so that the diode is really reverse-biased. With a 100-watt bulb as a light source and using a 1N34-A you should get 20–30 μa, easily read with a vom.

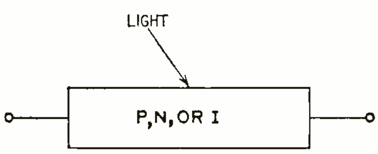

Fig. 5—Photoresistor made of p, n or intrinsic material.

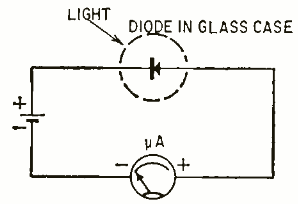

Fig. 6—Circuit for checking effect of light on diode. Use either point-contact or junction diode.

A phototransistor is similar to a photodiode, except that it is physically identical to a transistor instead of a diode. Either p-n-p or n-p-n phototransistors are possible. In operation the base lead is not used, but the normal collector-to-emitter bias is applied. The current will be the normal cutoff current until light is applied to the collector junction. Then current rises sharply to a value about β times the equivalent photodiode current. Transistor action accounts for this amplification of the hole-electron pairs formed. The phototransistor can be considered a photodiode with a built-in amplifier.

Photovoltaic cells

A photocell that does *not* require a bias is the photovoltaic cell. Its physical structure is the same as the photodiode, and it can be used either way—as a photodiode or as a photovoltaic cell.

Strange as it may seem, if you shine light on an ordinary diode, you will develop a voltage across it. If the circuit is closed, current caused by the light will flow. For absolute proof of this effect you can try it yourself. Use any diode—point-contact or junction—that has a glass case. On bright illumination the output will be readable on a vom. The same setup as Fig. 6 can be used, without the battery.

The so-called barrier-layer photocell is nothing but a photovoltaic cell. Again, the practical devices were in use long before the theory was well developed but, along with the theory, came improved techniques for making the devices, improved efficiencies, better materials, etc. The physical shape of present-day photovoltaic cells and the materials used differ from the early models, but the fundamental process is the same.

Photovoltaic cells are used in photographic exposure meters and in many control applications. Practically any semiconductor can be used—typical cells use copper oxide, selenium, germanium, silicon, etc.

Because they require no bias, photovoltaic cells are useful for converting energy—they can be used as a battery. Shine light on the device, and the energy of the light is converted into electricity. The solar battery developed at Bell Telephone Laboratories is a photovoltaic cell designed specifically for energy conversion. Another similar device is one of the recently announced nuclear batteries. Instead of trying to convert nuclear energy directly into electrical energy, the inventors let the nuclear radiation hit a fluorescent material so it would glow, like a "radium" wristwatch dial. This light was used to power a photovoltaic cell.

Another type of photocell which is useful for converting energy, since it requires no bias, is the PME photocell, or the *P*hoto*M*agneto*E*lectric cell. This was developed simultaneously by two groups, one in England and the other in France, a few years ago. The principle is very simple.

Fig. 7 shows the device. It is similar to the Hall-effect devices (described last month) except that, instead of the current from left to right, the electrons and holes are supplied by light. Electrons and holes are formed right at the surface and they tend, because of their large numbers, to move away from the surface. As they diffuse back into the material, they get caught by the magnetic field and the holes are pushed up and the electrons down. Then a voltage appears across the two terminals—the PME voltage. Thus, the PME cell takes advantage of the Hall effect operating

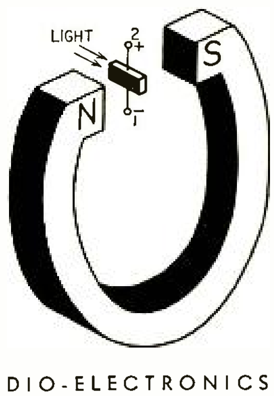

Fig. 7—PME photocell uses Hall effect acting on light-induced electrons and holes.

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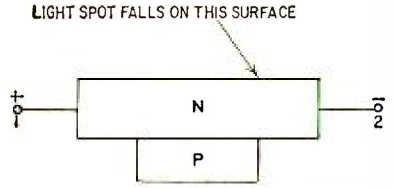

Fig. 8—The Wallmark lateral-effect photocell.

on the electrons and holes formed by the light.

The PME effect is used to measure certain properties of the semiconductor and is in less use as a practical photocell. It has certain advantages, however, and in the future will be used more, both as an indicating device and as a battery.

Just one more type of photocell, now —the Wallmark lateral-effect photocell. The theory here is a bit more complicated, but the device has some unique properties. As Fig. 8 shows, it consists of a p-n junction with two contacts to the n-material. If one of these contacts and a contact to the p-region were used, we would have an ordinary photodiode or photovoltaic cell. However, we prefer to use the two contacts to the n-region. The p-n junction then becomes a floating junction since no net current passes through it.

If the device is lighted with a small spot right at the center, nothing will happen except that a photovoltaic voltage will be generated. The two terminals (1 and 2) will be at the same voltage. However, if the spot is moved to one side or the other, the action of the floating junction is to cause a voltage between terminals 1 and 2. This lateral-effect photocell, developed by RCA, tells us the position of the spot of light—something none of the other photocells would do. Useful in many control applications, this photocell, not yet commercially available, will find many specialized applications.

Heat-operated devices

There are many ways to use the unique temperature properties of semiconductors. Thermistors or diodes can be used for reading temperature. For heating or cooling objects, we can use a Peltier refrigerator. We can use a thermocouple as a battery. All this is possible with semiconductors because the effects are more noticeable than with metals.

A thermistor is merely a piece of semiconductor with two leads on it. It is useful because its resistance depends on the temperature—the higher the temperature, the lower the resistance, *contrary to the way metals act.*

A thermistor can be used to "read" temperature, the same way a photoresistor is used to "read" light intensity. The action of these two devices is quite similar.

Thermistors are made in many sizes and shapes for all types of control purposes. They are useful, for example, in controlling the bias of a power transistor stage, to prevent the transistor's burning up at higher temperatures.

A diode also can be used as a thermometer. Diode reverse current is a very sensitive indication of the temperature. In this respect it is similar to a photodiode whose reverse current is a very sensitive indication of the light level.

Thermocouples have been known for some time. The basic circuit is in Fig. 9, showing two kinds of conductors (here copper and iron) connected together to form two junctions—one at the end on the left, and the other at the voltmeter. If the junctions are not at the same temperature, there will be a voltage generated by the thermoelectric or Seebeck effect. This effect has been used for many years to measure temperatures, since the voltage output depends only on the temperatures of the two junctions and on the type of material used.

For measuring purposes, the materials are usually metals and the output voltages run a few millivolts. The possible power output is so small that it would not be practical to use such a system as a battery. However, using semiconductors, the output voltages are hundreds of times larger, and it is quite practical to build semiconductor heat batteries which are really nothing more or less than simple thermocouples. Many such thermocouples can be connected in series or parallel to provide whatever current or voltage is needed.

More work is required to make such thermocouple batteries cheap enough to be practical. However, for the power-starved areas of the world, even expensive batteries are better than none, especially since these thermocouples require no maintenance and no charging. This type of battery, using semiconductors, has been developed in Russia and China to run small transistor radios. The higher temperatures are produced by a kerosene lamp. The thermocouples are mounted on the lamp's chimney to use the heat that would otherwise escape. It is only a matter of time before this type of battery can be made cheap enough to be useful throughout the world.

One more important device using semiconductors and heat is the Peltier refrigerator. The Peltier effect is the direct opposite of the Seebeck effect—instead of getting a voltage generated by a difference in temperature, now we get a difference in temperature caused by a current passing through a junction. The same device that works as a thermoelectric battery will also work as a refrigerator, although not too efficiently.

It is somewhat baffling to understand how passing a current through a junction will cool it, especially when all our experience tells us material heats when current is passed. The two processes, however, are different. With metals, ordinary I^2R heating is much more important. Even with semiconductors, special pains have to be taken to detect the slight cooling that is possible. However, under the right conditions, with enough junctions and the right material, with the current set at just the right level, appreciable cooling is possible. Within a few years you can expect to see electric Peltier refrigerators, home freezers and air conditioners. The advantage is that there is no electric motor, no fluid or piping, nothing to wear out, and no maintenance required.

Other semiconductor devices

One other application for semiconductors should be mentioned because it is surprising that semiconductors should be used at all. We normally think of the transistor and the vacuum tube as competitors in some sense. Yet vacuum tubes use semiconductors in their construction.

Most modern vacuum tubes use an oxide-coated cathode, so the heater can be run at a lower temperature. The oxide used is a semiconductor—and the lower temperature comes from the unusual properties of semiconductors. Here, they allow the electrons to escape more easily.

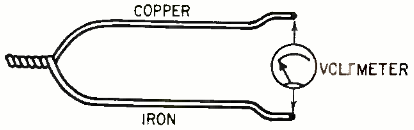

Fig. 9—A basic thermocouple. Its output can be used to indicate temperature or run transistor equipment.

Among the devices used to detect *nuclear radiation* is the crystal counter whose resistance changes sharply when it is hit by a particle from a radioactive material. The action of this type of counter is similar to the action of a photoresistor when a light photon hits it—electron-hole pairs are formed. The material used is a semiconductor, and the electrons and holes formed after each hit are removed quickly. The pulses of current can then be counted, giving us a practical radiation detector.

If this last device is similar to a photoresistor, picture a device that is similar to a photovoltaic cell but uses nuclear radiation to form the electron-hole pairs, instead of light. This device can be used as a battery if a piece of radioactive material is placed near it. This then is a *direct* way to convert nuclear energy into electrical energy. In the future, special semiconductor materials will be used to give us nuclear batteries with very desirable properties.

Of all the devices described here, no one can predict which will become the most important. There is no doubt that the transistor has arrived. But remember it was only 10 years ago that the first crude transistor was made. Enough is now known about semiconductors to make many other devices possible, as outlined in this article. I wonder how many of these will become as commonplace in the *next* 10 years as the transistor is now. END

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Simple electronic computer adds, subtracts, divides and multiplies

Mr. Math

Analog Computer

By FORREST H. FRANTZ, SR.

INDUSTRY spends millions of dollars each year for computing instruments to free engineers, technicians and office workers from the labor of doing long computations by hand. Time that was spent doing this work is now used in more creative and productive pursuits.

Can this work for you as a service technician, ham, hi-fi enthusiast or experimenter? Yes, it can! With a modest calculator you can enjoy these benefits on a smaller scale. Mr. Math is just such an instrument. It will help you make accurate calculations for most electronic and electrical problems. Mr. Math opens the door to analog computing for you. You'll find math less laborious and more interesting. Your understanding and ability to use it advantageously will increase as you use Mr. Math.

What Mr. Math can do

What can you expect from Mr. Math in problem ability and accuracy?

Ability: Mr. Math can be used to work problems involving these commonly encountered formulas:

$E = IR$, $I = E/R$, $R = E/I$,
$P = E^2/R$, $P = I^2R$, $e = E_m \sin\theta$,
$e = E_m \cos\theta$, $X_L = 2\pi fL$,
$X_C = 1/(2\pi fC)$, $Z = \sqrt{R^2 + X^2}$,
$\tan\theta = X/R$, $\cos\theta = R/Z$,
$\sin\theta = X/Z$, $X = R \tan\theta$,
$X = Z \sin\theta$, $R = Z \cos\theta$,
$\text{Gain} = E_{out}/E_{in}$,
$\text{Gain} = \mu Z_L/(r_p + Z_L)$, $\mu = g_m r_p$,
$f_o = 1/(2\pi\sqrt{LC})$, and others.

Accuracy: 1% is usually considered adequate for engineering purposes. Mr. Math is accurate within 1% when carefully constructed, calibrated and used for most problems. With average construction, calibration and use, Mr. Math's error will be less than 3%.

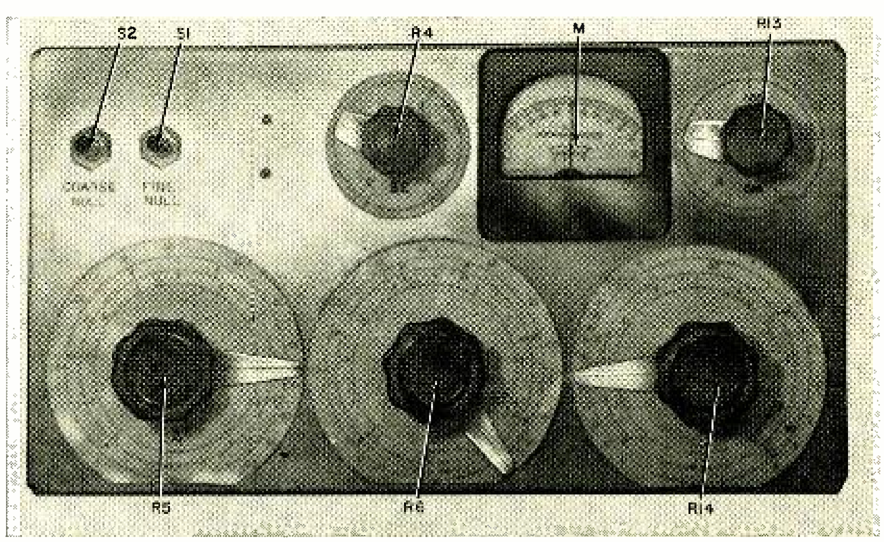
Here's how Mr. Math is used:

Problem: You're fixing an old ac–dc radio that has a burned-out series-heater resistor. The total drop across the tubes must be 68 volts at 0.3 ampere. The line voltage is usually 120 in your locality. What should the resistance of the replacement be and how much power will it have to dissipate?

All you do to solve the problem is set four dials to obtain the resistance in ohms and readjust two of them to obtain the power in watts that the resistor will dissipate. Simple, isn't it?

Mr. Math's circuit is simple, but, before you become too involved with it, glance at Fig. 1-a. A battery of voltage E is connected to series resistors R1 and R2. In a series circuit, the current through each resistance is the same and the sum of the voltage drops across the resistances is equal to the battery voltage. Therefore, V2 = I R2. And, if R1 plus R2 equals 1,000 ohms and R2 equals 200 ohms when E is 10 volts, V2 will be 2 volts. Thus, V2/E equals 0.2.

If resistances R1 and R2 of Fig. 1-a are replaced by a potentiometer as shown in Fig. 1-b, voltage V2 may be varied by rotating the pot's shaft. R1 plus R2 is constant and is equal to the potentiometer's total resistance. R2 is equal to the percentage of shaft rotation times total resistance. Total mechanical rotation possible with the potentiometers used in Mr. Math is 300°. But, the metal connector tabs on the ends of the resistance element take up 10° each. Therefore, the electrical rotation is only 280°. So a 28° rotation of the shaft corresponds to a 10% rotation, and V2 will increase by 10% of E. If the potentiometer has a scale with ten 28° divisions, each marked from 0 to 10, and E is 10 volts, a



Mr. Math ready for use.

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pointer knob on the potentiometer will indicate the magnitude of V2 directly in volts. Thus we've generated the numbers between 0 and 10.

How can we multiply?

With a little thought, you will see that we already know one way to multiply. In Fig. 1-b we multiplied E by numbers between 0 and 1 and, when E equaled 10, generated the numbers between 0 and 10. This was done when the potentiometer input voltage was constant. If we add a second potentiometer with its outer terminals across V2 as shown in Fig. 1-c, we can multiply V2 by another number between 0 and 1. We can calibrate R_{TB} from 0 to 10 if we wish and increase E to 100 volts. Thus, with R_{TB} and R_{TA} set to 10, we have 10 × 10 = 100. However, there's no need to let the number 1 equal 1 volt. If we let it equal .01 volt, we can let E equal 1 volt and still graduate the potentiometers from 0 to 10. Thus, for 2 × 4, V3 equals .08 volt, or 8 units. A voltmeter with the proper

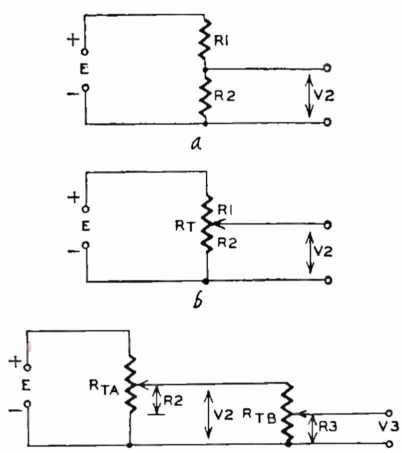


Fig. 1—Basic system of generating numbers and multiplying with cascaded potentiometers.

range could be calibrated to read directly in units from 0 to 10, and the meter range switch could be calibrated in multiples of 10.

To make the multiplication method of Fig. 1-c work properly, R_{TB}'s resistance should be at least 10 times R_{TA} if you want to use linear scales. Even then, there'll be some error (approaching 2% maximum) if you try to use linear scales. Furthermore, to multiply more than two-digit numbers with a string of cascaded pots, you run into the problems of using a large input voltage, a very low resistance for the first potentiometer to get a reasonably low resistance for the last pot and a very-high-sensitivity meter for answer readout. Another disadvantage is that you cannot divide unless you provide a reciprocal scale (difficult to make and use) and multiply to divide. Thus, 3 divided by 7 would be 3 times 1/7.

But, there's another way to multiply and divide that is also handy for squaring and taking cube roots.

You can multiply by adding, and can

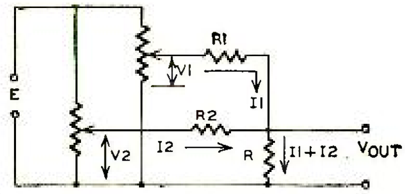


Fig. 2—Electronic adding with a mixing circuit.

divide by subtracting, logarithms. Recalling your high school math, let the letters A and B represent numbers. Then, the *log* of A times B is equal to the *log of A plus the log of B*. And the *log* of A divided by B equals *log A minus log B*. To use these principles in our analog calculator, we need only find a method for adding either voltages or currents.

Let's use a signal mixer

The circuit in Fig. 2 is familiar to most people in electronics. It's a simple signal mixer usually used to mix phono and mike inputs for a single-channel amplifier. The output voltage (V_{out}) is proportional to V1 + V2.

Now, to get back to multiplication and division. Granting that logarithms are to be used for multiplication and division, Mr. Math would have a limited value if we had to resort to log tables. To get around this, we provide the potentiometers with log scales for these tasks. With *log scales and linear scales* we can multiply, divide, add or subtract.

To simplify Mr. Math's design further, a simple bridge circuit is used. In this way, the need for a more expensive output meter is eliminated, and problem answers may be read from a 280° potentiometer scale instead of a 90° meter scale. Furthermore, division and subtraction may be done without reversing the voltages applied to the potentiometers. The multiplication scheme for Fig. 1-c is important though, and it is used in Mr. Math to square and to take square roots. The math principle involved is that *the log of A squared* is equal to *two times the log of A*. Similarly, *the log of the square root* of A is *one half the log of A*.

Mr. Math's circuit

Now let's take a closer look at the circuit (Fig. 3) of this calculator we're going to build. The letters which identify the potentiometers correspond to the front-panel markings on the controls and dials. Pot A(R5) furnishes a voltage output proportional to a dial-number setting as explained in conjunction with Fig. 1-b. Pot B (R6) furnishes a voltage output proportional to a dial-number setting multiplied by the control pot BE (R4) setting of ½, 1 or 2. This circuit is similar to that of Fig. 1-c. The outputs of pots A and B add in the summing network consisting of R7, R8 and R9. This is an application of the circuit of Fig. 2. The voltage representing this sum is introduced to one side of the meter. The sum of the output of pots C (R14) and CM (R13) connects to the other side of the null meter. This summation takes place in the summing network consisting of R10, R11 and R12. The output of pot C is proportional to the number set on the dial. The output of pot CM is proportional to 0, 1 or 2.

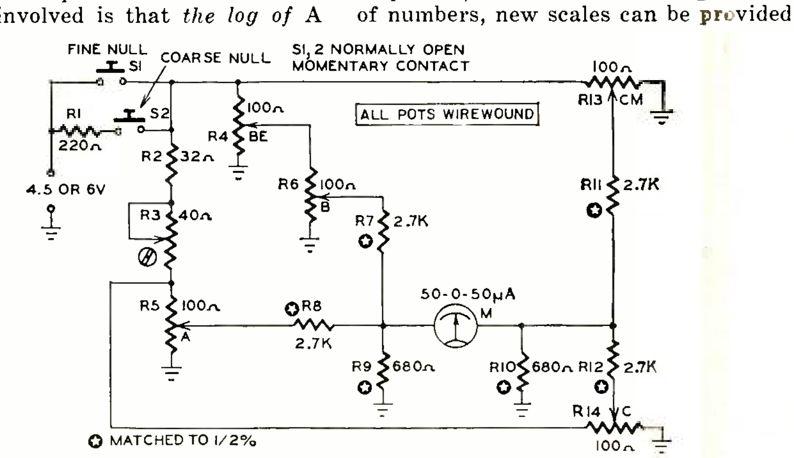
The numbers stated are for the linear scales on the dials (see Fig. 4) The calculator equation for meter null with these scales is:

(A) + (BM) (B) = (CM) + (C)

where BM = 0, ½ or 2; CM = 0, 1 or 2 and A, B and C are continuously variable from 0 to 1.00 with dial scale divisions of .02.

This equation provides for adding and subtracting. But Mr. Math computes to only two significant figures. Since addition and subtraction can be performed rapidly with paper and pencil, principal calculator applications are in multiplication and division.

By assuming that the linear scales of pots A, B and C are the logarithms of numbers, new scales can be provided



R1—220 ohms
R2—32 ohms
R3—pot, 40 ohms, wirewound, screwdriver adjust (Mallory C40P or equivalent)
R4, 5, 6, 13, 14—pots, 100 ohms, wirewound (Clarostat 58C1-100 or equivalent)
*R7, 8, 11, 12—2,700 ohms, matched to ½%
*R9, 10—680 ohms, matched to ½%
All resistors ½-watt 10% unless noted
**Use 1% resistors if you do not have access to a Wheatstone bridge*
M—50-0-50 μa (Triplett 327-T or equivalent)
S1, 2—spst, normally open, momentary contact type (Cutler-Hammer 8411-K4 or equivalent)
Chassis, 2 x 13 x 7 inches
Knobs
Miscellaneous hardware

Fig. 3—Mr. Math's easy-to-build circuit.

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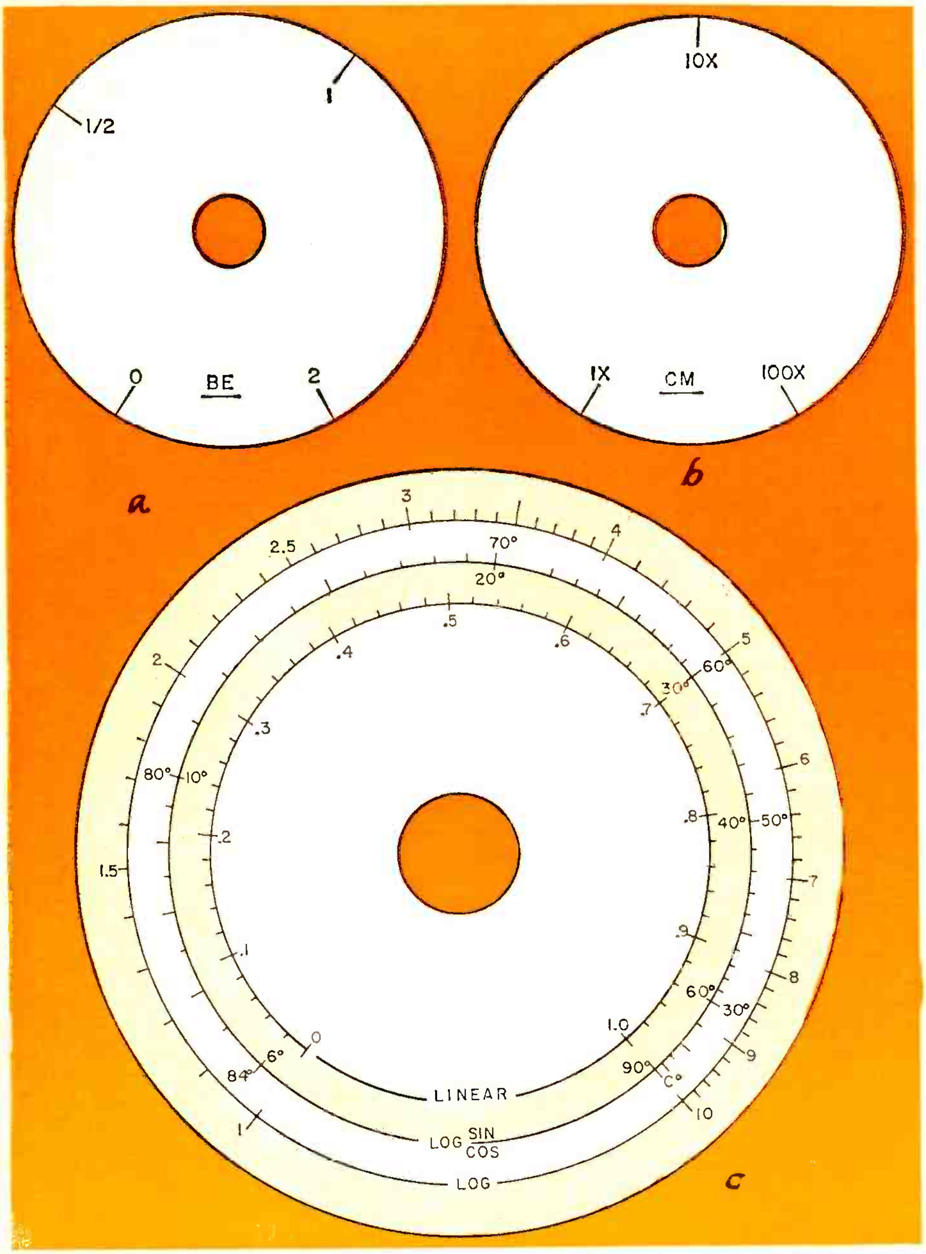
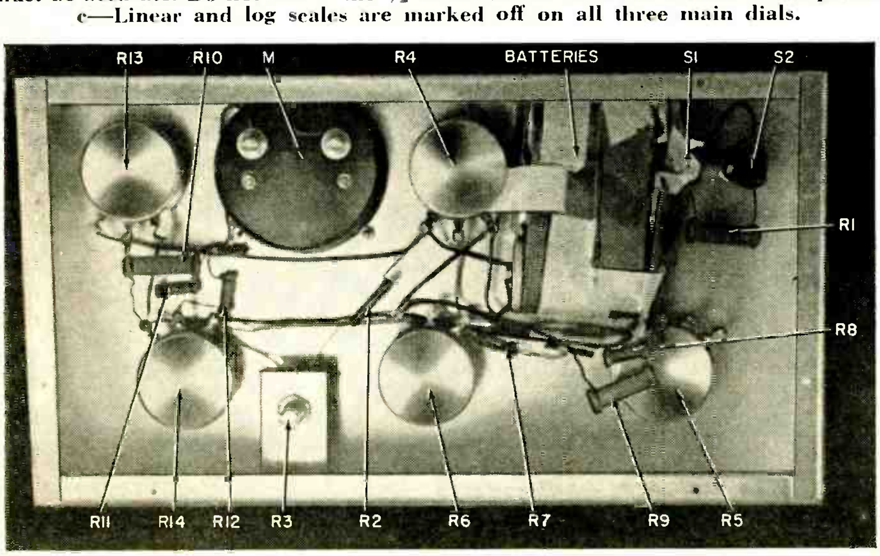


Fig. 4—Calibrated dials for Mr. Math: a and b—The end marks (0, 2, 1X and 100X) are placed at the extremes of the mechanical rotation (300°). In use, these dial settings are not critical. The ½, 1 (on BE) and the 10X (on CM) settings must be accurate. Do not ink in the ½ mark on BE until calibration is completed. c—Linear and log scales are marked off on all three main dials.



Inside view shows location of parts. I taped the batteries to the case, but a battery holder could be used for a more secure mounting.

which are logarithmically related to the linear scale. Thus, with Mr. Math you can multiply, divide, square and take square roots. These are the most commonly required calculations in electronic work and they're the most time-consuming.

The calculator equation for Mr. Math using the log scales (outer scale in Fig. 4) is:

$$A \times B^{BE} = C \times CM$$

where BE = ½ (for taking the square root of B),
= 1 (if B is not to be squared or its square root taken)
or = 2 (if B is to be squared)
CM = 1, 10 or 100 (to set the decimal point for the number on pot C)

A, B and C are continuously variable from 1 to 10. Trig scales and scales of numbers multiplied by commonly used constants (eg, 2π) may be laid out against the log scales to increase Mr. Math's memory.

The three large dial scales have a 4-inch diameter. These are prepared by first laying out a linear scale with a radius of 1¼ inches. The calibrated portion of the scale covers 280° and principal divisions are spaced 28° apart. The full-scale value is 10 and the 10 principal divisions are numbered from 0.1 to 1.0. After these are laid out, a 1¾-inch radius circle is drawn for the logarithmic scale. The principal points for this scale were laid out using a log table or a slide rule. Remember that the inner linear scale corresponds to logarithms. There is enough space for an additional scale with a radius of 1½ inches on each dial. My calculator has a log 2π scale in this space on the A pot dial, a log tangent–cotangent scale in this space on the B pot dial and a log sine–cosine scale in this space on the C pot. The explanation of these middle scales and their layout is difficult. Unless you've had a good bit of trigonometry, I suggest you wait to lay these out until you've become accustomed to Mr. Math's operation with the inner and outer scales. Mr. Math's scales are somewhat consistent with slide-rule scales. This allows you to use either without confusion if you know how to use a slide rule or learn how to use one in the future.

The calculator draws current from the battery only when the COARSE NULL or the FINE NULL button is depressed. The COARSE NULL switch is depressed first and an approximate null is established. Then the FINE NULL switch is depressed and fine null is established.

Calibrating Mr. Math

A series of adjustments of the pointer knobs and one semifixed pot is used to calibrate your calculator. The technique used is to set in several sample problems and adjust for the correct answer. You might call it an approximation method. Here's what to do:

1. Index knobs. Proper indexing is set when the hairline overrides the extreme clockwise and counterclockwise index marks by equal amounts.

2. Set controls so that (numbers given for A, B, and C are on linear scales)

A = 0, B = 0.5, C = 1.0,
BE = 2, CM = 1X

Adjust the 40-ohm screw-adjust pot under the panel (R3) for null with the fine-null switch depressed.

3. Set controls so that

A = 0, B = 0.5, C = 0,
BE = 2, CM = 10X

Check the null. If it is poor, adjust CM for null with the fine-null switch depressed. Loosen the knob setscrew on CM and move the knob until the hairline coincides with 10X again. Tighten the knob setscrew. Check to be sure that the null was not disturbed.

4. Set controls so that

A = 0, B = 1.0, BE = 1,
C = 1.0, CM = 1X

Depress the FINE NULL switch. If the null is not exact, turn BE for exact null, loosen the setscrew on BE and adjust the knob till the hairline coincides with 1. Tighten the knob setscrew. Check to be sure that the null was not disturbed.

5. Set controls so that

A = 0, B = 1.0, BE = ½,
C = 0.5, CM = 1X

Depress the FINE NULL switch. If null is not exact, adjust BE for exact null and place a new graduation line for ½ on BE.

The dial indexing and calibration should be rechecked if error greater than 3% is noted on any calculation.

To use Mr. Math

The calculator is used as follows:

1. To add two numbers (3.5 + 4.5, for example) use linear scales.
- **a.** set A at 0.35.
- **b.** set B at 0.45.
- **c.** set BE at 1.
- **d.** set CM at 1X.
- **e.** adjust C for meter null, read answer on C. C nulls at 0.80. (The answer is 0.80 × 10. The multiple is used since the numbers were divided for entry.)

NOTE: If the sum of the numbers is greater than 10, set CM to 10X. The answer is 10 plus the number at which C nulls. Thus to add 7.2 and 8.7:
- **a.** set A at 0.72.
- **b.** set B at 0.87.
- **c.** set BE at 1.
- **d.** set CM at 10X.
- **e.** set C for meter null, read answer on C. C nulls at 0.59. [The answer is 10 × (1 + 0.59) or 15.9.]

2. To subtract two numbers (8.3 – 4.1, for example) use linear scales.
- **a.** set B to 0.41 (number to be subtracted).
- **b.** set C to 0.83 (number to be decreased).
- **c.** set BE to 1.
- **d.** set CM to 1X.
- **e.** adjust A for null. A nulls at 0.42 (The answer is 10 × 0.42, or 4.2.)

3. To multiply two numbers (3.9 × 7.1) use log scales.
- **a.** set A at 3.9.
- **b.** set B at 7.1.
- **c.** set BE at 1.
- **d.** set CM at 1X.
- **e.** attempt to adjust C for null. If null is not possible, set CM to 10X and adjust C for null. C nulls at 2.77. (The answer is 10 × 2.77, or 27.7.)

4. To divide one number into another (26/3.1, for example) use log scales.
- **a.** set C to 2.6.
- **b.** set CM to 10X.
- **c.** set BE at 1.
- **d.** adjust A for null, and read answer on A. A nulls at 8.4. (This is the answer.)

5. To square a number (7.9², for example) use log scales.
- **a.** set B at 7.9.
- **b.** set BE at 2.
- **c.** set A at 1 on log scale.
- **d.** set CM at 1X and adjust C for null.
- **e.** If no null can be obtained, set CM to X10 and adjust C for null.
- **f.** C nulls at 6.22 with CM at 10X. (the answer is 6.22 × 10, or 62.)

6. To take the square root of a number (8) use log scales.
- **a.** set B at 8.
- **b.** If number has odd number of places, set A at 1. If number has an even number of decimal places, set A at 3.16. Set A at 1.
- **c.** set BE at ½.
- **d.** set CM at 1X.
- **e.** adjust C for null. C nulls at 2.8. (This is the answer.)

Since the computer may have an error of 1 or 2%, answers should be read out to only two significant figures. Thus, 27.7 should be read as 28, 272 as 270.

Since the A, B and C log scales are scaled from 1 to 10, multipliers of 10, 100, etc. are used to represent numbers greater than 10. Thus to multiply 71 × 832, the dial settings of A and B are the same as for 7.1 × 8.32, and the result from CM and C is multiplied by 10, 100 or 1,000 to get the final answer.

The trigonometric scales (which I suggested you add later) are actually 10 times the respective functions which they represent. This requires the use of a scaling factor in the answer. Thus 5 tan 45° gives the result 50 on C and CM. This result must be divided by 10 to obtain the correct answer.

To get most accurate results from your construction work:

a. Match R7, R8, R11, and R12 within ±½% with a Wheatstone bridge.

b. Match R9 and R10 within ±½%.

c. Use the potentiometers specified; others may not possess the linearity required.

d. Prepare dial scales accurately. Be sure knob pointers fit close to scale to prevent parallax errors.

e. Calibrate carefully according to the procedure outlined.

f. Set numbers into the calculator accurately when working problems.

Happy calculating! END

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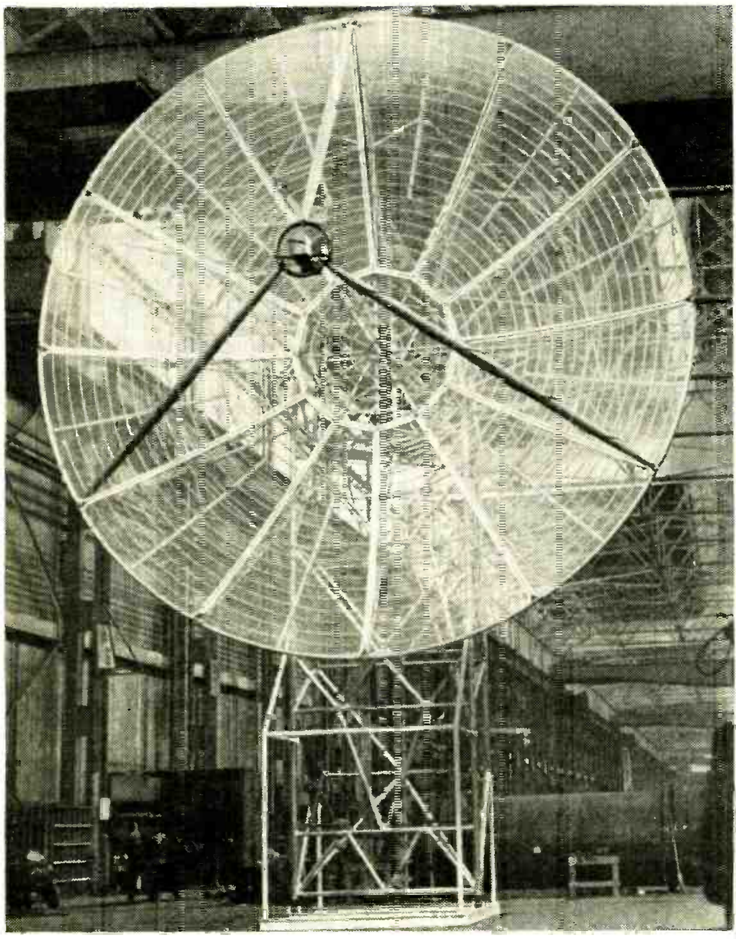
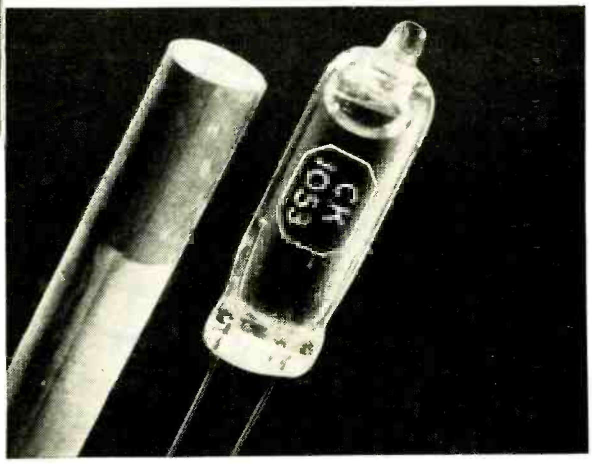
NEWS from the IRE 1958 meet



55,000 electronic engineers gather to discuss another year of progress

This mobile antenna stands almost three stories high—its radiation center is 24 feet above the ground.



The Raytheon operating-time indicator tube.

By ERIC LESLIE

THE year's most striking example of how fast yesterday's wonders become commonplace was probably the 1958 convention of the Institute of Radio Engineers, held in New York City the third week of March. The engineers not many years ago had thrilled to the news that a radar message had been returned from the moon—now they talked calmly about shooting a manned rocket around it. Medical electronics was married to computer technology, and the old concept of gas tubes was expanded out of recognition. (Engineers talked of a plasma of electrons and ions at a temperature of 100 million degrees, carrying currents several times as great as could an equivalent bulk of copper, and held in an envelope consisting of a magnetic field that would constrict the plasma on itself.)

A complete session was in fact devoted to thermonuclear power. Another, a panel, was entitled Electronics in Space. A more mundane subject that would have been equally surprising to the old engineer was engineering education. Two sessions were devoted to that subject, and another to a related one, engineering writing and speech. Devices that would read books and papers, then prepare engineering abstracts from them, were described, as well as an electronic Russian translater.

Another complete session was devoted to masers (microwave gas or semiconductor amplifiers) and atomic

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clocks. One of these—a gas-cell clock described by Federal Telephone engineers—was visualized as "necessary equipment on any rocket ship."

Luminescent panels for flat-tube television were discussed by Sylvania engineers, who pointed out avenues of research in that direction and reported on progress in producing moving pictures on such panels, but concluded that "major breakthroughs" would be needed before luminescent panels could be used as TV screens.

The field of sound

Audio was possibly the livest subject at the convention. One complete session was devoted to stereophonic disc recordings, and another to audio, amplifier and receiver developments. It was at that session that Dr. Peter Goldmark presented his surprise paper on the CBS compatible stereo-disc system.

It resembles the Westrex 45/45 system in general (Dr. Goldmark suggested that the 45/45 might be considered a special case of the CBS technique), but avoids some of the disadvantages of that system by putting most of the program into the lateral signal fed to the cutter. Only a few percent of the total signal remains for the vertical component. The record can be played back perfectly (as a monaural recording) with an ordinary long-play cartridge. As a stereo disc it can be played with any 45/45 setup, or even with a vertical–lateral cartridge. This last feature caused Goldmark to describe it as "compatible even with the incompatible!" Wear—either with a stereo or long-play pickup—was stated to be the same as with a regular long-play record.

[Stereo developments at the convention were sufficiently important to justify a complete article. This is being prepared by Mr. Norman H. Crowhurst, and will probably appear in an early issue.]

Computers and therapeutics

Biology was one of the important subjects. One session was devoted to medical electronics and one to biological transducers.

Top item on the medical–biological program was an infra-red spectrometer–computer for analyzing complex biochemical mixtures such as hormones. The instrument, developed by International Telephone & Telegraph Corp., is expected to be of great value in cancer research. In analyzing by chemical methods, one constituent is identified and removed from the compound, then the process is repeated for another—a time-consuming and laborious process. The new method, explained president Henri Busignies of Federal Telecommunications Labs (research division of IT&T), is to treat the absorption spectrum of the compound as a signal and to use the communications man's long experience with mixing and unmixing signals to discover not only the components of the compound but also their relative quantities.

A pressure transducer, working on the strain-gauge principle, that can take measurements of blood pressure inside the human heart, at the same time bringing back blood samples from the heart's interior, was discussed by electronics researchers of the Ford Motor Co. laboratory.

Another paper described the use of a Nipkow disc in making biological microphotographic measurements, and still another covered the electronic evaluation of the condition of the unborn fetus.

An electronic postoffice

Experiments in electronic mail sorting had been started before last year's convention. This year a whole session was devoted to the method being tried at Ottawa, Canada. Each letter is re-addressed by an operator, the new address being put on the back of the envelope in fluorescent ink. A simple code, easily learned by unskilled labor, is used. From this point, the various sortings for province, city and street address or carrier's route are entirely electronic.

An almost opposite system, which handles preliminary sorts only, is undergoing experiment at Washington, D. C. Letters fed to the electronic machine are sorted by states—and a few cities. The apparatus reads type-written addresses in various sizes of type, but cannot as yet read hand-written addresses nor those written in all capitals.

Broadcast techniques

A new concept in the broadcasting field was presented by Leonard Kahn, developer of a compatible single-side-band AM transmission system. Described a year ago in the *Proceedings of the IRE*, the system has been tried out by several stations, including New York's WMGM and WABC. One sideband is greatly reduced in power without making special receiving techniques necessary, as in conventional types of single-sideband transmission. The reception in fringe areas is improved, since more power is concentrated in the single sideband, and fading—often due to interactions between the two sidebands—is not so marked. Interference can be reduced because of the smaller bandwidth of the single-channel signal.

Multiplex transmission received a couple of papers. Color TV was represented by a few scattered papers at different sessions.

The IRE show

The exhibition which is so impressive a part of the annual meetings was on a highly practical level, following last year's pattern of accenting improvements on existing practice rather than strange new equipment. One old-timer was heard to murmur that he could remember when the bulk of the exhibits had to do with entertainment electronics—broadcasting and receiving equipment—but that now it had become practically a pure military–industrial setup. A number of striking things did however appear among the 17,000-odd pieces of equipment exhibited.

One of these was an elapsed-time tube exhibited by Raytheon. It looked like a miniature tube envelope with two terminals, filled with a bluish liquid. This liquid, a copper sulphate solution, gradually clears up as current passes through it, till—at the end of 20,000 microampere hours—it is entirely clear. If one wishes to find out how long a piece of equipment has been in operation while the tube still shows considerable color, a colorimeter indicates the number of microampere hours rather accurately. The device—if it reaches the popular market—should have a number of interesting applications. The high-fidelity enthusiast would be particularly interested. He could hook up one of these tubes in a circuit drawing 20 μa dc, and at the end of 1,000 hours the clear liquid in the tube would tell him it was time to replace the diamond stylus.

A battery-operated TV set was another interesting exhibit. The battery consisted of 10 Yardney Silvercells and a solid-state converter manufactured by Interelectronics Corp. Viewers were informed that it would operate the set up to 6 hours and could be recharged overnight (at a low charging rate).

Inertial guidance systems were displayed by a number of exhibitors. Inertial guidance is a method of locating one's position on the globe by starting from a fixed known point with equipment that tells how far and in what direction one moves. It consists of a "stable table" that maintains its position with relation to the earth and to any change in the position of the vehicle carrying it. Three gyroscopes, one in each direction of motion, give it that stability. Accelerometers take note of any acceleration in any of these directions, and electronic devices record their output in terms of direction and distance. It is a system which might be called super dead reckoning, and can be used—for example—by a submarine traveling under Arctic ice, to indicate its position accurately.

A number of other displays were impressive in themselves, but revealed no startling advances in electronics. One, a portable antenna, brought back to the minds of old-timers the early days of portable radios, some of which were said to be best transported by Mack truck. The antenna, exhibited by Kennedy Corp., was a parabola 28 feet across. It looked substantial enough for any permanent job, but two rubber-tired wheels were visible part way up the tower, and the whole job could be demounted and towed by a pickup truck. Probably it is the biggest piece of portable electronic equipment that is in existence. END

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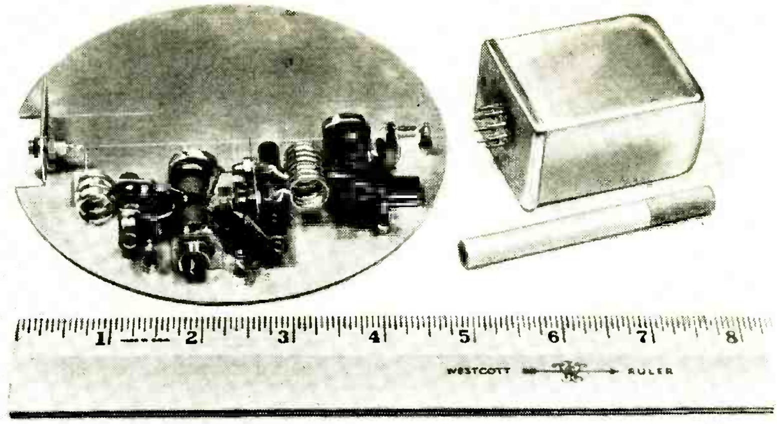
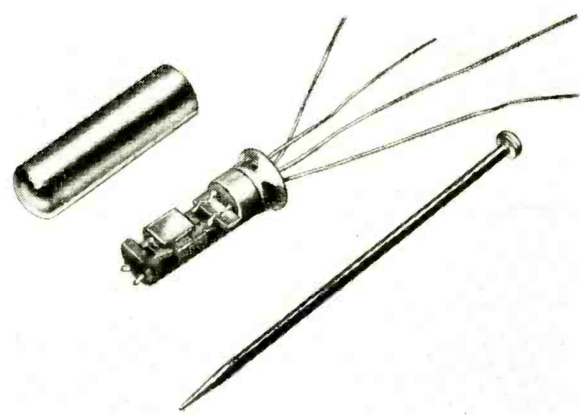
what's new?



SATELLITE TRANSMITTER with 500-mw output is smaller than a pack of cigarettes. It weighs less than 3 ounces and takes up less than 6 cubic inches of space. Operating at 108 mc, the crystal-controlled transmitter uses three transistors. The unit, which operates 1¼ to 4 times as long as existing transmitters, was constructed by engineers of the DuKane Corp., St. Charles, Ill., under contract to the Naval Research Laboratories.

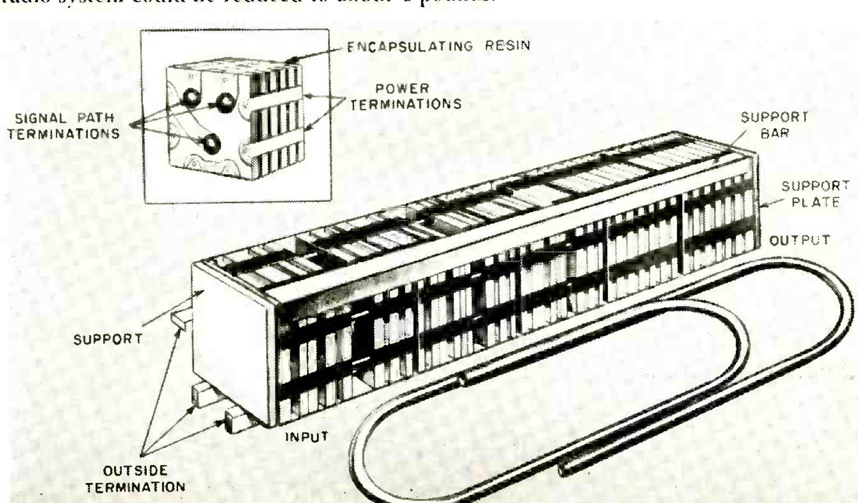
ULTRASONICS CLEANS DISHES in this dishwasher. The noiseless machine thoroughly cleans dishes, pots and pans in seconds with sound waves pitched too high for the human ear to detect. The prototype model shown in the photo was manufactured by Acoustica Associates, Inc., Culver City, Calif., and may be commercially available before the end of the year.

GERMANIUM RESISTANCE THERMOMETER for measuring temperatures near absolute zero is dwarfed by a common pin. The heart of the unit is a tiny bridge of arsenic-doped germanium. The doped germanium presents a variable resistance to currents flowing through it. Temperature is measured by determining the potential drop when a small known current (approximately 10 μa) is passed through the bridge. Developed at Bell Telephone Labs, the unit may be useful for accurately measuring temperatures in outer space, when mounted in a suitable carrier.



GLASS TRANSISTOR HOUSING developed by G-E is the first in glass to meet the JETEC-recommended standard for low-power transistors. Eventually, mass-produced glass transistors may be much cheaper than those with metal cases.

FIVE-STAGE MODULAR RADIO RECEIVER little bigger than an ordinary paper clip illustrates a new miniaturization technique. Using micro-modules (see photo insert), employing transistors and greatly reduced wiring, a typical missile guidance unit's size and weight could be reduced 90% or more. Developed by RCA, now under 2-year contract to the Army Signal Corps, the final aim of the project is to bring micro-module construction to the point where the weight of a 30-pound airborne radio system could be reduced to about 4 pounds.



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TRANSISTORS In The TV SET

Part II—We complete our survey of the transistor TV receiver with a trip through the audio if, audio amplifier, audio output, sync separator, high voltage, and horizontal and vertical sweep circuits

By LOUIS E. GARNER, JR.

LAST month we examined the early stages of the transistor TV receiver. We discussed the front end, video if strip, video detector and video amplifiers. Now we will continue our first detailed look at an all-transistor TV set.

Audio if amplifier

A transistor TV receiver's audio if strip will probably consist of one or two stages, with the final stage driving a standard FM detector circuit modified to use semiconductor diodes in place of vacuum tubes. A deluxe receiver might use a three- or four-stage audio if amplifier, with the last stage or two serving as limiters, followed by a conventional discriminator type FM detector.

A two-stage 4.5-mc audio if amplifier and ratio detector circuit is shown in Fig. 5. Transistors V10 and V11 serve as common-emitter amplifiers. Rf transistors would be used in these stages, with suitable units including surface-barrier rf triodes, tetrodes and drift types. We have assumed the use of p-n-p rf transistors here.

The 4.5-mc signal obtained from the video amplifier is link-coupled to if transformer T10. A tap is provided on this unit's secondary winding to insure a good impedance match to V10's input circuit. Base bias current for the first stage is supplied by voltage divider R39–R40, bypassed by C31. Emitter resistor R41, bypassed by C32, establishes a small reverse bias for stage stabilization. R42 and C33 form a decoupling filter in V10's collector circuit.

Transformer T11 has a tuned primary winding and an untuned stepdown secondary. The primary–secondary turns ratio is chosen to provide a good impedance match to V11's base input circuit. A tap is provided on the transformer's primary to provide an optimum compromise between circuit Q and stage gain.

V11's base bias is furnished by voltage divider R43–R44, bypassed by C34. Unbypassed emitter resistor R45 introduces a small amount of degeneration to improve circuit stabilization. R46 and C35 form a decoupling filter.

The amplified audio if signal developed across transformer T12's primary is coupled to its center-tapped secondary and to coil L13. From here, the signal is applied to an FM detector which abstracts the audio modulation from the FM if carrier. The FM detector used in Fig. 5 is a modified ratio detector, with the customary vacuum-tube diodes replaced by semiconductor diodes D1 and D2, shunted by resistors R47 and R48. C36 serves as the if bypass and C37 as the dc stabilizing capacitor. The audio output signal is obtained through filter R49–C39.

Audio amplifier

The audio signal obtained from the ratio detector is next fed to audio amplifier and output stages very similar to those used in present-day transistor radios. Standard audio transistors would be used in these circuits. However, chances are that the output stage will supply more power than a portable radio. To conserve operating power, the output stage may be operated as a class-AB or class-B push-pull amplifier, with medium-power transistors in portable sets and large multiwatt transistors in receivers intended

(*Continued on page* 76)

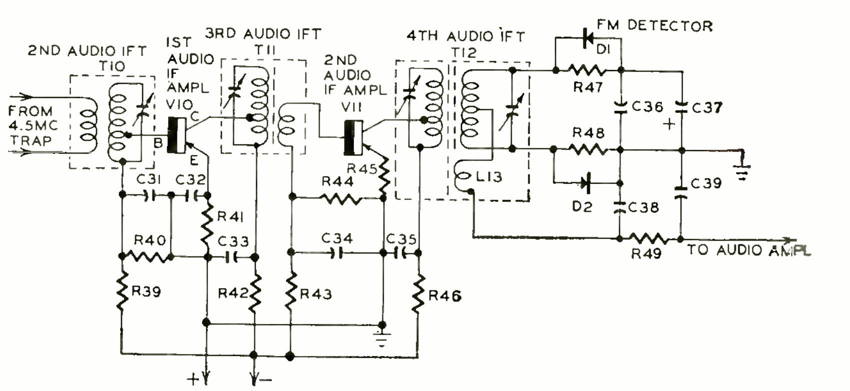

Fig. 5—The audio if strip. Two if amplifiers, and two diodes for FM detection are used.

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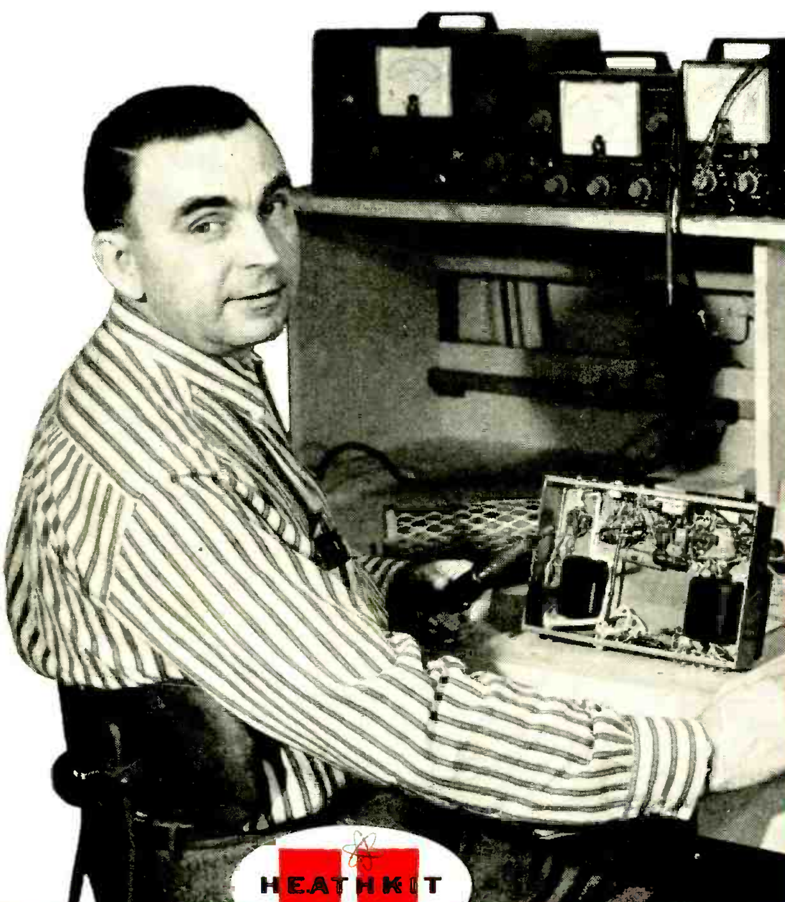

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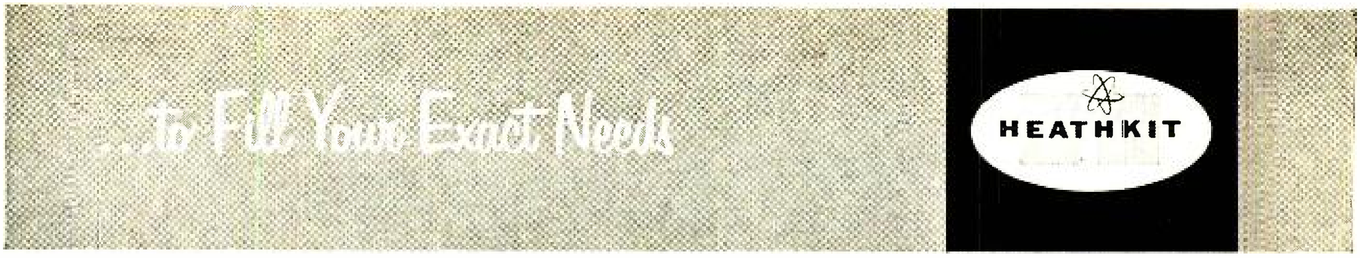

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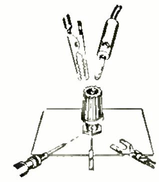

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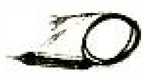

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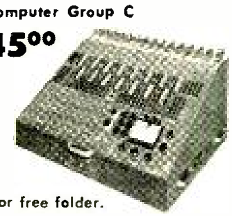

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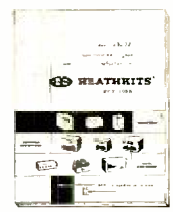

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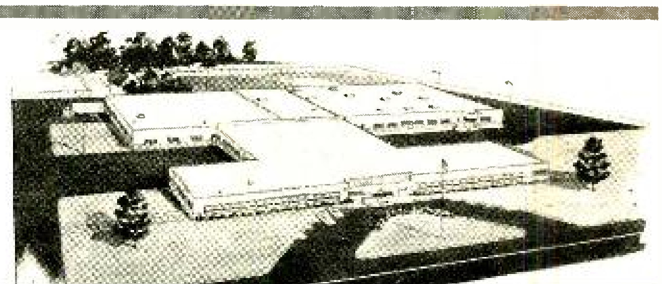

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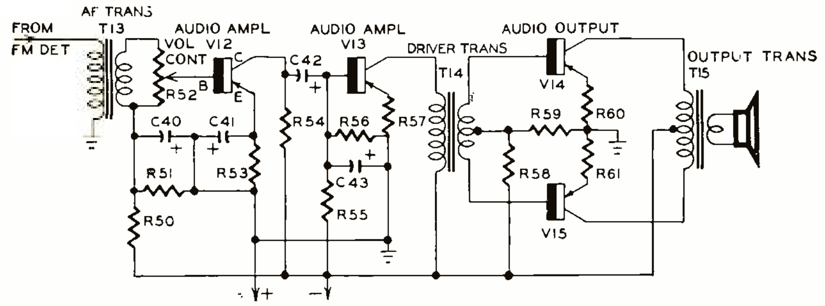


Fig. 6—Circuit of the audio amplifier and output stages.

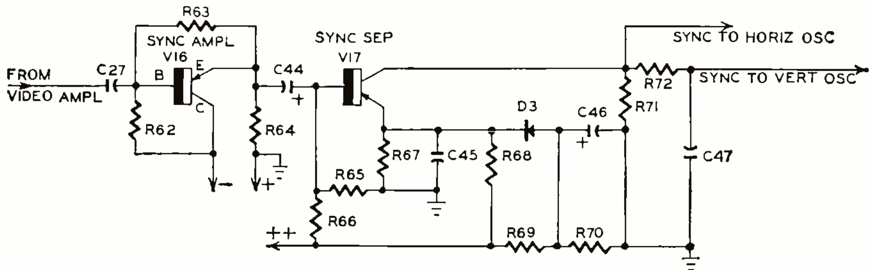


Fig. 7—The sync separator uses two p-n-p transistors and a crystal diode to do its job.

(*Continued from page* 59)
for home use (such as large consoles).

The circuit of a typical audio amplifier section is given in Fig. 6. This amplifier consists of two common-emitter "gain" stages driving a common-emitter push-pull output amplifier which, in turn, drives a PM speaker. All transistors are p-n-p units.

In operation, the audio signal obtained from the ratio detector is coupled through impedance-matching transformer T13 to V12's input circuit. Potentiometer R52, across T13's secondary winding, serves as a *volume* control. Base bias for the first stage is supplied by voltage divider R50-R51, bypassed by C40. Emitter resistor R53, bypassed by C41, insures stable operation. R54 is V12's collector load.

The amplified audio signal appearing across R54 is coupled through capacitor C42 to V13's base. This stage's base bias current is supplied by voltage divider R55–R56, bypassed by C43. An unbypassed emitter resistor, R57, is provided to do a threefold job—it stabilizes stage operation, reduces distortion by introducing a small amount of degeneration and increases V13's input impedance. Driver transformer T14 matches V13 to the push-pull output stage. A stepdown turns ratio is used here.

Transistors V14 and V15, together, form the power output stage. Base bias current for these transistors is furnished by voltage divider R58–R59. Small unbypassed emitter resistors R60 and R61 minimize the effects of differences between V14 and V15 and thus insure balanced operation. Finally, the amplified output signal is coupled through output transformer T15 to the loudspeaker's voice coil.

Sync separator

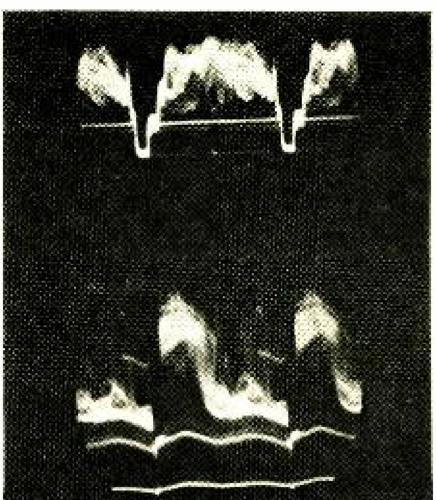
Many types of transistor pulse-shaping, clipping and amplifying circuits have been developed for use in military equipment and in electronic computers. Thus, the problem of sync-pulse separation is a relatively minor one. Chances are that a commercially manufactured TV receiver will employ a one- or two-stage sync separator, using high-speed switching or rf transistors in these stages. The schematic of a typical sync separator is given in Fig. 7. This circuit includes an impedance-matching common-collector amplifier (V16) and common-emitter sync separator (V17). Both stages use p-n-p's.

In operation, the video signal obtained from the video amplifier is coupled through dc blocking capacitor C27 to V16's base circuit (waveform is shown in Fig. 8). Base bias current for this stage is provided by voltage divider R62–R63, with resistor R64 acting as the emitter load. The use here of a common-collector amplifier minimizes loading on the video amplifier. As the reader may recall, a common-collector circuit, in contrast to the more popular common-emitter configuration, has a *high* input impedance. The signal appearing across R64 (see Fig. 9) is coupled through dc blocking capacitor C44 to V17's base input circuit.

V17 is biased so that it is driven to collector-current saturation by the peaks of the applied video signal. This establishes the amplitude of the peak pulses developed across collector load resistor R71 at a relatively fixed value and, to some extent, clips off noise peaks of greater amplitude than the sync pulses. This saturating action is achieved, even with comparatively weak input signals, by using a combination bias voltage which includes fixed and variable components. A fixed bias is applied by voltage divider R65–R66, and a variable bias is developed in the emitter circuit, appearing across R67. The latter bias, in turn, depends on collector current and the ratio of bleeder resistor R68 and emitter resistor R67, R69, R70, C46 and D3 improve the circuit's immunity to noise signals while, at the same time, providing optimum separation of vertical sync pulses.

To see how this noise-immunity circuit works, let us first consider the circuit's operation when handling normal (noise-free) sync pulses. Under these conditions, emitter current biases diode D3 in its low-resistance (or conducting) direction, permitting R69, R70 and C46 to become part of the emitter-to-ground circuit. In effect, C46, a fairly large capacitor, is shunted across C45, and the emitter bias circuit has a fairly long time constant. This permits optimum separation of the broad, low-frequency vertical sync pulses.

If a high-amplitude noise signal is applied to the stage, D3 is still biased in its forward (conducting) direction and the action is as before. However, under these conditions, C46 can charge to a peak voltage higher than that to



Courtesy of Motorola, Inc.

Fig. 8—Waveforms at V16's base; (top) 60-cycle sweep; (bottom) 15,750-cycle sweep.

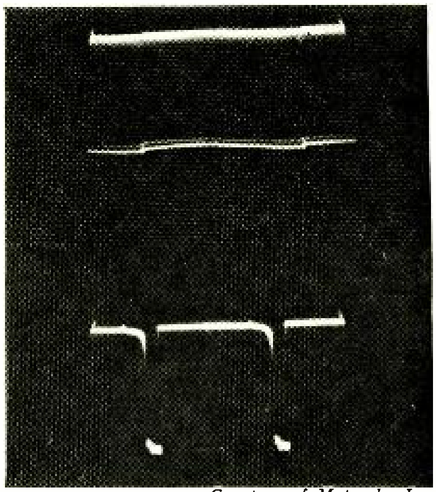


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Fig. 9—In some transistor receivers, this waveform will be present at V16's base; (top) 60-cycle sweep; (bottom) 15,750-cycle sweep.

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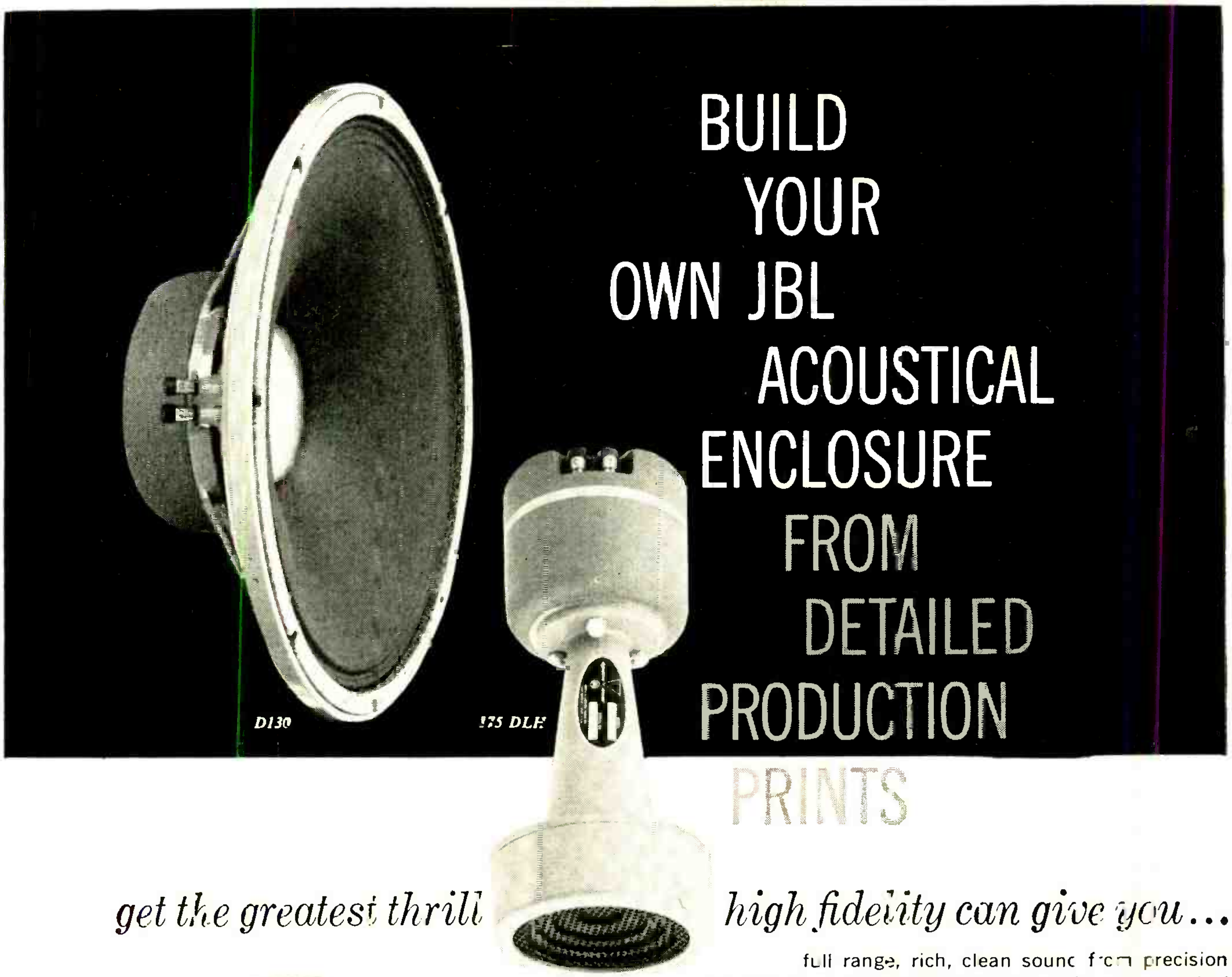

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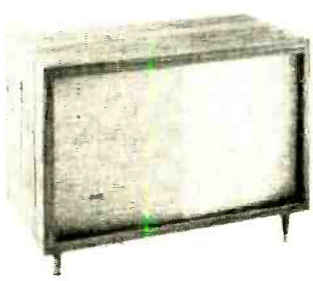
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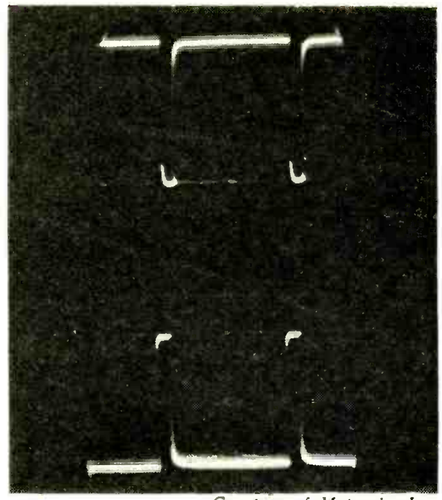

Courtesy of Motorola, Inc.

Fig. 10—Waveforms at V17's output; (top) at the collector, 15,750-cycle sweep; (bottom) at the emitter, 15,750-cycle sweep.

which it is charged by the average sync pulses. When this occurs, the voltage across C46 is such as to place a *reverse* bias on D3, and C46 is effectively removed from the emitter-to-ground circuit. Thus, the time constant of the emitter biasing circuit changes from a large to a relatively small value (C45 is *much* smaller than C46). This lets the sync separator recover from noise pulses more quickly and allows a normal separation of horizontal sync pulses.

The stage continues to operate with a short time constant in its emitter biasing circuit until C46 discharges through R70. Then normal operation is resumed. This C46–R70 time constant is long enough to insure good noise immunity, but not so long as to interfere with the circuit's recovery in time to separate the next vertical sync impulse.

The sync pulses separated by V17 and appearing across R71 (see Fig. 10) are fed to the horizontal and vertical sweep oscillator circuits. R72 and C47 form an integrating network for the vertical sync pulses.

Sweep and high-voltage circuits

As in vacuum-tube TV receivers, the sweep oscillators may employ any of a variety of basic circuits—multivibrators, blocking oscillators, various types of relaxation oscillators and so on. In addition to the basic oscillator types available to vacuum-tube circuit designers, many specialized semiconductor oscillators suitable for use in sweep oscillator circuitry employ special-purpose devices such as G-E's Unijunction transistor, IBM's "thyratron" transistor and Shockley's bi-stable diode.

Transistor deflection circuits are, in a way, easier to design than vacuum-tube sweeps. For one thing, CRT deflection yokes are, in general, low-impedance devices. Vacuum tubes are high-impedance devices. Thus, considerable effort must be expended simply to match the output of a high-impedance tube to a low-impedance yoke winding.

This problem is exemplified by the circuitry used in the horizontal output stages of most commercially available TV receivers. This stage alone generally requires a medium-power vacuum tube and may consume as much as 40 watts (three times as much as a complete transistor TV receiver may need). Theoretically, however, almost *zero power* is required to deflect a CRT's electron beam. The high power required of a typical horizontal output stage is used almost entirely to make up for circuit losses.

While we can expect much better efficiency from transistor deflection amplifiers, typical deflection circuits will probably use one or more power transistors. Such transistors are needed to supply the high peak deflection currents required, but probably will not be used at their maximum power ratings. In many cases, the deflection yoke windings may be direct-coupled to their respective sweep output stages; the output impedance of a power transistor and the input impedance of a yoke are on the same order of magnitude.

The high dc voltage needed for the CRT's anode may be obtained in much the same way as in vacuum-tube TV sets. That is, autotransformer action might be used to step up the pulse developed during the horizontal deflection circuit's retrace (or "flyback"), with this new pulse rectified by appropriate semiconductor rectifiers. Voltage-doubler or -tripler circuits may be used if necessary.

High voltage also can be obtained by using transistor rf or pulse type power supplies. In such circuits, one or more additional power transistors would be employed in the receiver's circuit, together with a suitable oscillator transformer, and rectifier and filter components.

A typical *horizontal deflection* and *high-voltage* circuit is shown in schematic form in Fig. 11. This circuit includes a relaxation oscillator (V18), a common-emitter sweep amplifier (V19) and a voltage-doubler high-voltage rectifier (D5 and D6).

In operation, a Unijunction transistor, V18, is used as the oscillator. The circuit's basic repetition rate (frequency) is determined by the R-C time constant of R74, R73 and charge-discharge capacitor C49. Of these components, R74 is variable and acts as the horizontal hold control. The sync pulses from the sync separator are applied to V18's emitter circuit through dc blocking capacitor C48.

The negative-going pulses developed across load resistor R75 connected to V18's B2 electrode, are fed through coupling capacitor C50 to V19's base circuit. This p-n-p transistor is biased almost to cutoff by the small direct current delivered by voltage divider R77–R76 and acts as a switch, conducting heavily when pulses are applied to its base but remaining "off" at other times.

With a strong negative pulse applied to V19's base, this transistor conducts, charging C51 through the horizontal deflection yoke and starting the horizontal trace. At the same time, C52 is charged through T16, storing energy in both the transformer's winding and the capacitor. During this time, D4 is biased in its high-resistance (nonconducting) direction.

Once the initial pulse has passed, C52 can discharge through D4 and the

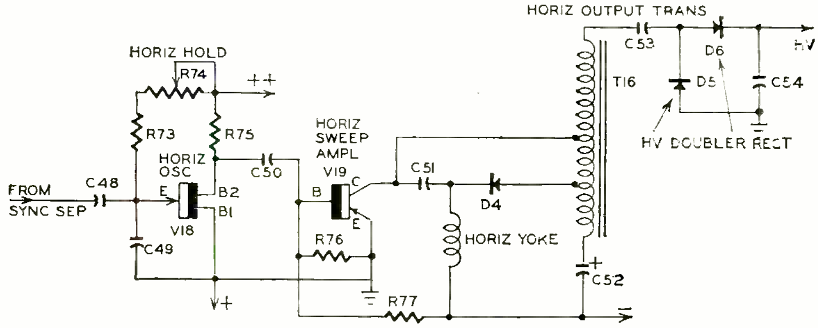

Fig. 11—Horizontal oscillator, horizontal output and high-voltage stages. A doubler rectifier and autotransformer are the major components in the high-voltage supply.

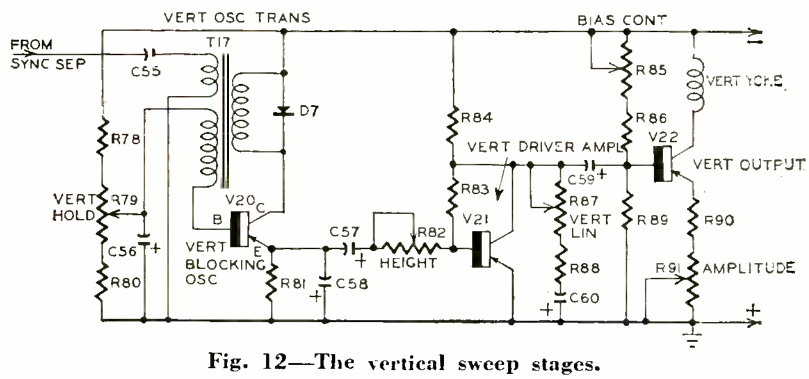

Fig. 12—The vertical sweep stages.

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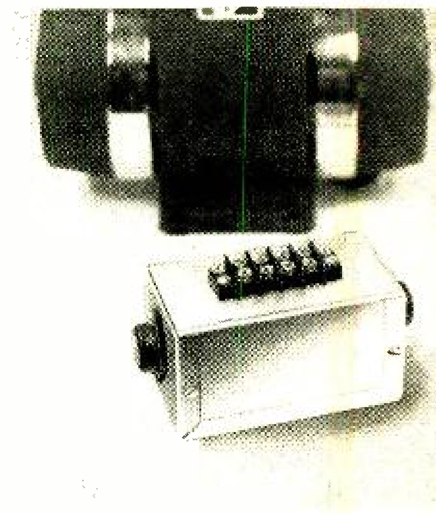

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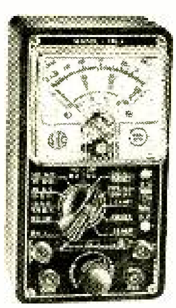

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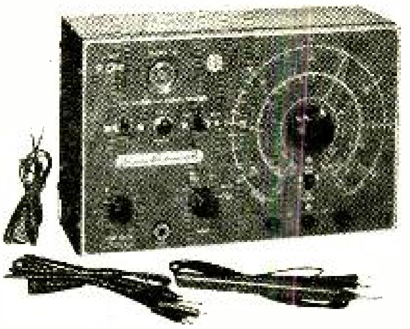

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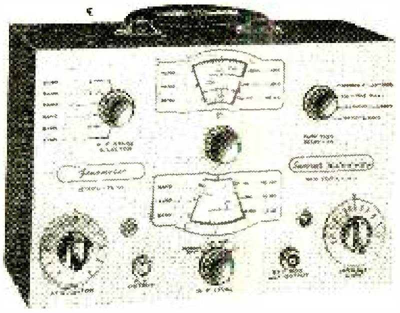

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horizontal yoke, continuing the horizontal trace. The transistor (V19) is *not* conducting at this time and, for practical purposes, is no longer part of the circuit. Finally, as C52 is discharged, the energy stored in T16 is suddenly released as the magnetic field built up during the initial current surge collapses. This strong pulse, applied to the deflection yoke, develops the necessary retrace signal. The circuit then receives another pulse from V18 and the action is repeated.

The retrace pulse developed by T16 is stepped up by autotransformer action and fed through C53 to a voltage-doubling rectifier circuit consisting of high-voltage semiconductor diodes D5 and D6 and filter capacitor C54. The high dc voltage developed across C54 is, in turn, applied to the CRT.

The circuit for a vertical sweep circuit is given in Fig. 12. This section consists of a blocking oscillator (V20), a driver amplifier (V21) and a vertical output stage (V22). All three use p-n-p transistors in the common-emitter configuration.

In operation, T17 is the blocking oscillator transformer. Two windings provide feedback between collector and base circuits to start oscillation, while a third winding is used to inject the sync-pulse signal obtained from the sync separator. The vertical sync pulse is applied to the third winding through dc blocking capacitor C55.

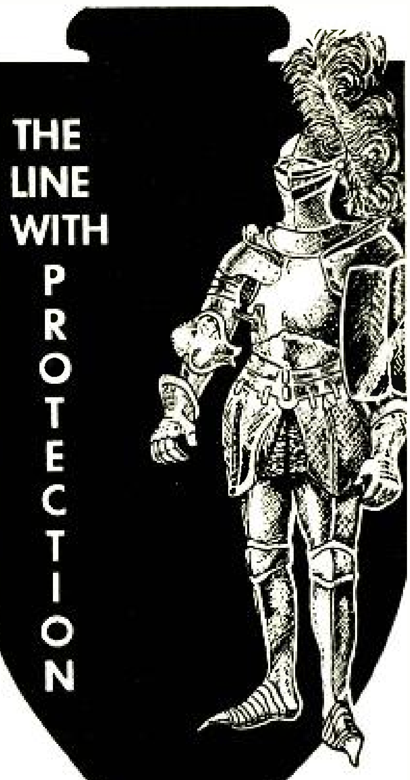
The blocking oscillator's basic repetition rate is determined by its base bias current and by the R-C time constant in its base circuit. The circuit's time constant is determined by the setting of R79, by R80 and by C56. R79's setting also determines base bias and hence this potentiometer becomes the vertical hold control.

Diode D7, across T17's primary, bypasses the unwanted half cycle of the blocking oscillator's pulse.

A sawtooth signal is developed across C58 as this capacitor is charged rapidly through V20 and discharged slowly through R81. This signal is coupled through C57 and R82 to the base electrode of the driver amplifier (V21). R82 provides a basic amplitude adjustment and thus serves as a height control. Base bias for this stage (V21) is supplied through collector load resistor R84 and base resistor R83.

The amplified and inverted signal appearing across R84 is coupled through capacitor C59 to output amplifier V22. The network consisting of potentiometer R87, fixed resistor R88 and capacitor C60 is included to provide a linearity adjustment; R87 is the circuit's vertical linearity control.

Base bias for the output amplifier is furnished by a voltage divider made up of potentiometer R85 and fixed resistors R86 and R89. R85 can be adjusted to provide optimum bias for the output stage whenever it is necessary to replace the vertical output transistor (V22). Unbypassed emitter



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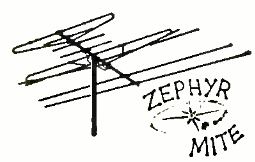

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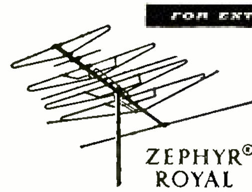

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resistors R90 and R91 help stabilize circuit operation. One of these resistors (R91) is made adjustable and serves as an additional amplitude control.

The vertical deflection yoke is direct-coupled to V22 and is its collector load. In this application, V22 is operated as a class-A power amplifier. As a result, the vertical deflection signal includes a large dc component which would normally shift the CRT's raster far to one side. This shift is corrected by placing small ceramic recentering magnets longitudinally in the vertical yoke's window.

To sum up

The transistor TV circuits we have discussed are based on circuits which have been investigated theoretically, studied experimentally and, in some cases, used in experimental transistor television receivers. They do not necessarily represent the final circuits which will be used when such sets are in full production. The development and manufacture of new types of semiconductor devices could result in considerable changes in basic circuit philosophy.

For example, the invention of an extremely high-gain high-frequency transistor could reduce the number of stages needed in the video if and video amplifier sections. Similarly, the development and manufacture of a semiconductor picture-reproducing device which could be used in place of a cathode-ray tube would require entirely different sweep circuitry and probably would eliminate the need for a high-voltage supply.

Finally, there are the day-to-day changes in television broadcasting. With the increased interest in color television, there is the real possibility that the first commercially produced all-transistor TV receivers will be color sets. There is also the possibility that some manufacturer, taking advantage of the sales appeal and public interest in transistors, may introduce a partially transistorized (or hybrid) set well in advance of an all-transistor reciever. END

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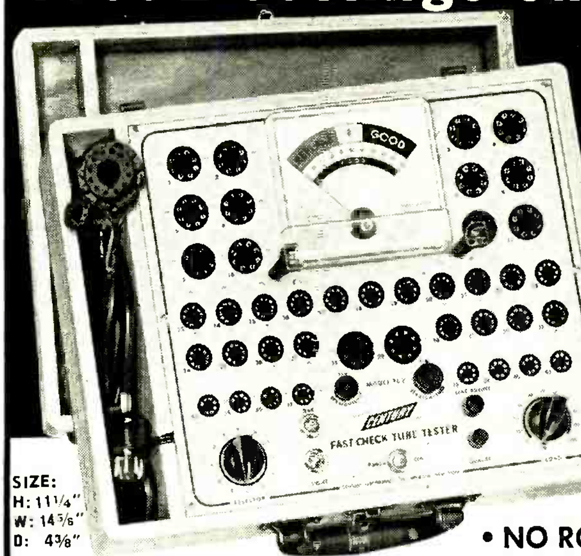

SIZE: H: 11¼" W: 14⅝" D: 4⅜"

• NO MULTIPLE SWITCHING
• NO ROLL CHART CHECKING

The FAST-CHECK enables you to save valuable time and eliminate unprofitable call backs. You earn extra money and win confidence by showing your customer the actual condition and life expectancy of the tube on the large meter scale of the FC-2. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

NEW Special compartment to accommodate line cord and CRT Test Adapter cable

CANNOT BECOME OBSOLETE

Engineered to accommodate all future tube types...new tube listings furnished periodically.

WIDE RANGE OF OPERATION

- Checks quality of over 600 tube types . . . more than 99% of all TV and radio tubes, including the newest series-string TV tubes, auto 12 plate-volt tubes, OZ4s, magic eye tubes and gas regulators.
- Checks inter-element shorts and leakage.
- Checks for gas content.
- Checks for life expectancy.

TRY THE FC-2 BEFORE YOU BUY IT!

Shipped on approval for FREE 10 day trial . . . No obligation to buy

IMPORTANT FEATURES

✓ Checks each section of multi-section tubes and even if only one section is defective the tube will read "Bad" ✓ 41 long lasting phosphor-bronze tube sockets accommodate all present and future tube types—cannot become obsolete ✓ Less than 10 seconds required to test any tube ✓ Large D'Arsonval type meter is extremely sensitive yet rugged—is fully protected against accidental burn-out ✓ Line isolated ✓ 7-pin and 9-pin straighteners conveniently mounted on panel ✓ Quick reference tube chart lists over 600 tube types ✓ Line voltage compensation

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NEW A specially designed PICTURE TUBE ADAPTER cable is now part of the FC-2 . . . making it a highly efficient CRT Tester-Rejuvenator. This feature eliminates the need of carrying extra instruments and makes the FC-2 truly an all-around tube testet, The adopter enables you to check all picture tubes including the new short-neck 110 degree picture tubes) for cathode emission, shorts and life expectancy . . . . also to rejuvenate and restore cathode emission of weak picture tubes.

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*Names on request

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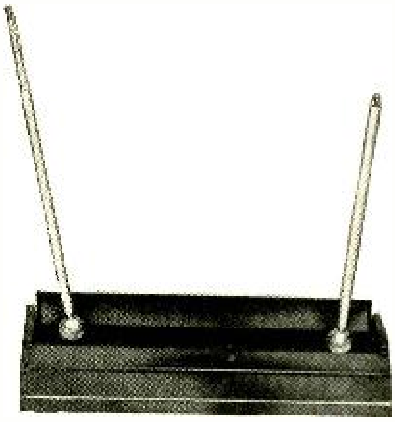
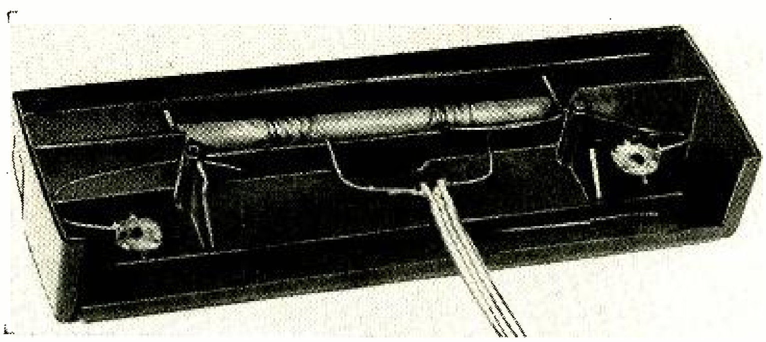
New look in indoor antennas

Electrical tuning, a 72–300-ohm matching network and small size are featured in this indoor TV antenna

By **LARRY STECKLER**
ASSISTANT EDITOR





(Top) Antenna elements are partially raised after the case has been opened. Tuning is adjusted with the little lever in the front. Bottom view shows the tuned coils and four-conductor matching network.

A NEW type of indoor TV antenna is now on the retailer's shelves. Called Vi-Fi (short for *Video-Fidelity*), it is different in both design and appearance—even has a flip-top box.

At the heart of this antenna are two coils wound on a common form and spaced about 3 inches apart. The inductances of these coils are simultaneously varied by an adjustable ferrite core. This electrically compensates for any variation from the theoretical element length. With previous types of indoor antennas, the length of the elements had to be adjusted or a multiple-position switch set to bring in the best picture.

The Slide Rule tuner (adjustable ferrite core) in the Amphenol Vi-Fi antenna permits adjustment without touching the elements, a major problem with some types of indoor antennas. When you touch the elements, the added body capacitance may result in an improper adjustment of antenna length. When you remove your hand, the picture fades away or distorts in one way or another. None of this takes place with the Vi-Fi. Coil matching also allows shorter elements—only 27 inches when extended.

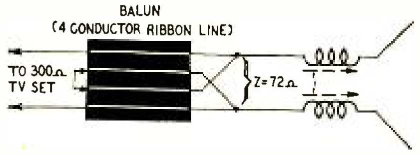


Fig. 1—Actual wiring of the antenna, matching network and tuning coils.

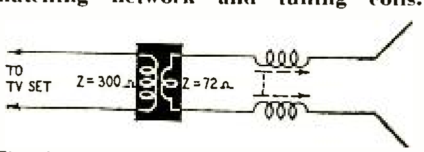


Fig. 2—Equivalent circuit shows impedance transformation from 72–300 ohms.

Another problem is matching the antenna to the set. The natural impedance of a dipole is approximately 72 ohms. The usual input impedance at a TV receiver's antenna-input terminals is 300 ohms. For best results the antenna's impedance must match the set's.

There are two ways to do this—either the dipole must be folded, increasing its impedance to 300 ohms, or some kind of matching network or transformer must be used. As a folded dipole is impractical and a matching transformer is bulky and expensive, a simple matching network is employed.

This network consists of a length of four-conductor ribbon line, which due to its construction transforms the dipole's 72-ohm impedance to 300 ohms. The actual wiring of this network is shown in Fig. 1 and the effective circuit in Fig. 2.

When tested in several metropolitan locations, the results were very satisfactory. It pulled in sharp, ghost-free signals with a high signal-to-noise ratio. Simply adjusting the Slide Rule tuner cleared up ghosts and snow in many instances.

The primary or local area for television reception is rapidly expanding due to increased station power output and improved receiver sensitivity. In many areas, the outdoor antennas, which pioneered the way for television, are fast becoming old and dilapidated. In many of these instances the old roof antenna can be replaced by a new indoor unit with excellent results. The Vi-Fi was designed to fit these conditions.

Since the elements of an indoor antenna need be extended only when in use, the antenna housing is designed so that the elements can be collapsed and folded down into the case when not in use. A roll-up type dust cover (flip-top box) was added so the case could be closed, and the antenna takes on the appearance of a cigarette or jewelry box.

As an aid to orientation, the element sockets are the ball joint type, allowing 360° rotation. Two angle brackets, provided with the antenna, permit back-of-the-set installation. Since back-of-the-set mounting is not always feasible, plastic feet are fastened to the bottom cover so the antenna can also be used on top of the set. The housing comes in three decorative colors, one of which will blend with your color scheme. END

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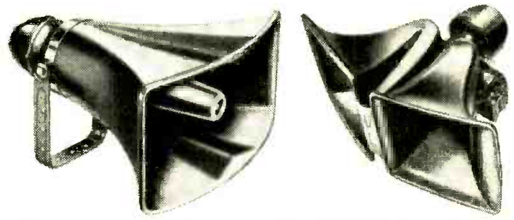
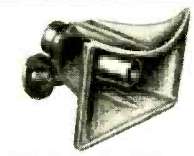


CLH 4½ ft. air column. Exclusive omni-directional bell and mounting bracket helps "tune out" reverberation and "dead spots." $44.50 list.

COBREFLEX All die-cast aluminum one piece construction resists a life-time of physical abuse. 2½ ft. air column. $38.33 list.

CIB Built-in hermetically sealed driver. Excellent for "talk-back." Exclusive Positive-Lok omni-directional mounting bracket. $42.00 list.



CMIL Smaller than CIB, perfect for voice. Built-in driver packs mighty wallop at low input power. Ideal for close quarter installations. $29.75 list.

MA-25 $27.50 list 85-6500 cps. 25 W.

SA-HF $35.00 list 80-10,000 cps. 30 W.

SA-30 $47.50 list built-in matching trans. 80-10,000 cps. 30 W.

PA-HF $42.50 list 70-10,000 cps. 50 W.

PA-50 $57.50 list built-in matching trans. 70-10,000 cps. 50 W.

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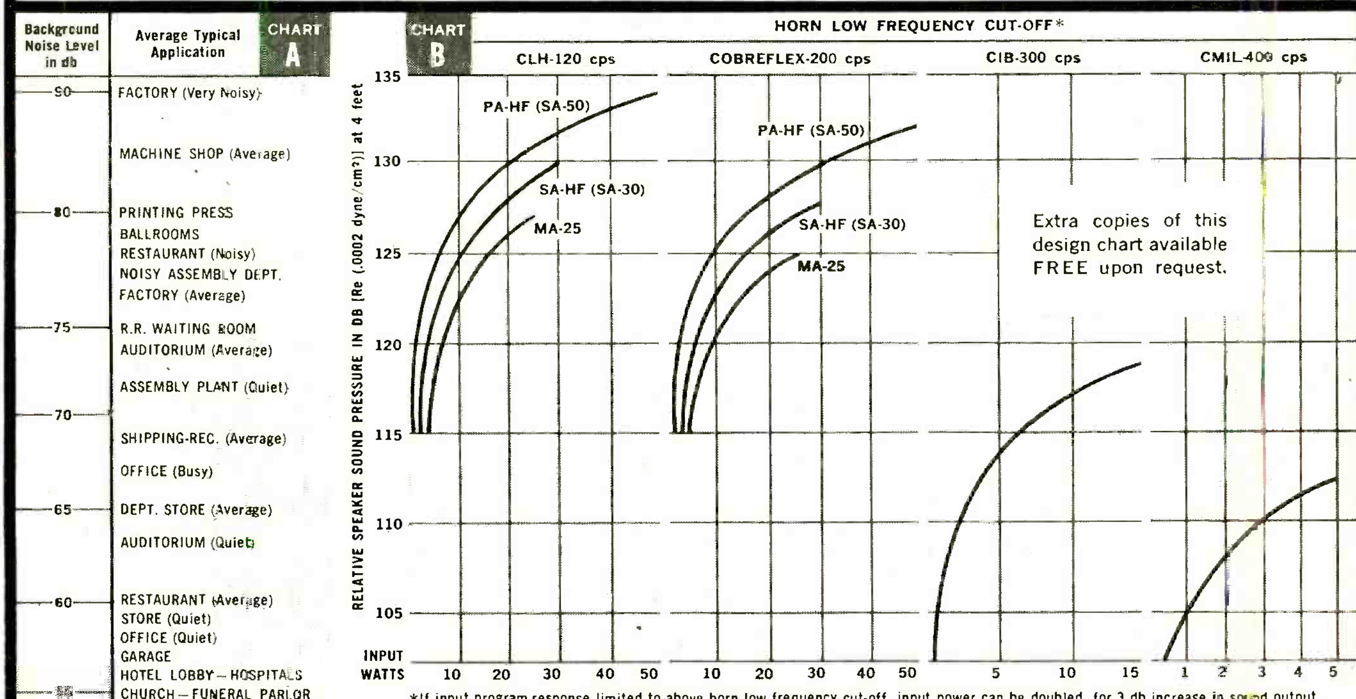
NOW AVAILABLE—Free Product Catalog. Or send $1 for the *NEW* 64-page University TECHNILOG, the complete speaker system planning manual. Desk J-4, University Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, N.Y.



*If input program response limited to above horn low frequency cut-off, input power can be doubled, for 3 db increase in sound output.

HOW TO USE THIS CHART

1. Determine sound pressure needed by finding noise level from Chart A, add loss of db in Table C and add adjusting factor in Table D.

2. Draw horizontal line across Chart B corresponding to the db figure just calculated. This now establishes which speakers can be considered.

3. A vertical line drawn to the base of Chart B shows the input power needed for each qualifying speaker.

4. Now, further selection may be based upon frequency response necessary (see Horn Cut-Off, Chart B), initial cost, operating economy and reserve power desired.

5. The CIB and CMIL may also be used in high noise levels by employing several throughout the listening area.

Example: Factory — noise level 90 db, 320,000 cu. ft., live acoustics, music and speech
90+25+5=120 db required

Qualifying speakers are CLH or Cobreflex, with any of the drivers. Final choice is determined by driver characteristics and installation problems. (Send for TECHNILOG or Product Catalog.)

TABLE C	INDOORS			OUTDOORS	
ROOM VOLUME CU. FT.	DB LOSS			FURTHEST DISTANCE FT.	DB LOSS
	LIVE	NEUTRAL	DEAD		
1,000	0	3	6	4	0
3,200	5	8	11	8	6
10,000	10	13	16	16	12
32,000	15	18	21	32	18
100,000	20	23	26	64	24
320,000	25	28	31	128	30
1,000,000	30	33	36	256	36

TABLE D		INDOORS DB	OUTDOORS DB
PROGRAM ADJUSTING FACTOR	SPEECH	4	7
	MUSIC	6	11
	MUSIC & SPEECH	5	9

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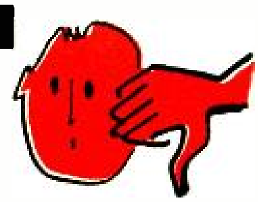
FACTS and FALLACIES in COLOR TV SERVICE



by ROBERT G. MIDDLETON

Some things we have learned carefully just ain't so!

The Fallacy	The Fact	Discussion
Color burst can be observed on a narrow-band scope if a demodulator probe is used.	The burst signal is not displayed.	The test fails because the *demodulating capability* of conventional demodulating probes is limited. Such probes are OK for sweep-frequency tests of chroma circuits, in which the modulation envelope has a 60-cycle repetition rate. However, they fail in burst-signal tests in which the modulation envelope has a 15,750-cycle repetition rate and a low duty cycle. *Use a wide-band scope with a low-capacitance probe.*
A scope is unsuitable for color TV service if it uses peaking coils in the vertical amplifier.	Chroma waveform displays are unaffected by peaking coils.	Wide-band scopes which use series and shunt peaking coils in the vertical amplifier are much less costly than those using distributed amplifiers. The assumption that a scope which uses peaking coils is unsuitable for color TV tests arises from the fact that such a scope will *ring* on square-wave signals that have a *very fast rise*. All chroma waveforms have a relatively *slow rise time* and *a wide-band scope with series and shunt peaked amplifiers is completely satisfactory for color TV tests.*
Individual cycles in the burst can be counted if a good scope is applied at the picture detector output.	It is usually impossible to display the individual cycles of the burst signal at the output of the picture detector.	The inability to display individual cycles of the burst signal at the output of the picture detector results from signal degradation by noise, cross-modulation with the sound signal, crosstalk with the sweep circuits and residual hum voltage. *Individual cycles of the burst signal can be counted only when the output from a color bar generator is viewed directly, prior to passage through the receiver signal circuits.*
Only a volt-ohmmeter is necessary for service in chroma circuits in a color TV receiver.	A volt-ohmmeter provides only preliminary test data. Good generators and scopes are essential for testing and adjusting chroma circuits properly.	Correct color reproduction depends greatly upon careful alignment of the chroma bandpass amplifier, burst amplifier, quadrature transformer and reactance tube circuits. For this purpose a good (crystal-controlled) color bar generator, wide-band scope, sweep generator with *flat* signal output and accurate (crystal-calibrated) marker generator are essential. The sweep generator must provide extended low-frequency output down to at least 40 kc, and preferably to 15 kc.
A white dot generator must also provide cross-hatch output to be useful in convergence procedures.	An equally good convergence job can be accomplished whether cross-hatch output is available or not.	Cross-hatch output is a *convenience* in preliminary convergence adjustments. For example, it is somewhat easier to adjust the vertical columns into parallel lines, and the horizontal rows into parallel lines when cross-hatch is used, because incidental displacement of *dots* may be a confusing situation to the beginner. *Final* convergence, however, *must* be accomplished upon the basis of a *dot* pattern. Cross-hatch *complicates* these final adjustments.
Good color reception can be obtained only if the antenna is very accurately oriented.	Extremely accurate orientation is not required. However, it is often helpful to use an antenna rotator if color programs are available on more than one channel.	The assumption that highly accurate antenna orientation is required for color reception arises from the fact that ghosts are more objectionable in color than in black-and-white. To the extent that an antenna rotator will minimize ghost signals, it will be found valuable in color TV reception.

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The Fallacy	The Facts	Discussion
Impedance matching is mostly a joke and does not need to be considered in practical work.	**Impedance matching is often a serious problem in color reception and a poor match may result in complete loss of color.**	Careless routing of the lead-in, branching of the lead-in to two or more receivers, faulty lightning arresters, a break in one side of the lead-in or faulty input circuits to the front end will often attenuate the color burst to such an extent that color sync drops out and color reproduction cannot be obtained.
Any antenna that provides good black-and-white reception is OK for color reception.	**Often untrue. If the black-and-white signal is analogous to the bass notes on a piano, the color burst and signal are analogous to the treble notes. Both low and high frequencies must be accommodated.**	Sharply tuned high-gain antennas, such as single-channel multi-element Yagis are least likely to provide good color reception although they are good for black-and-white. *Broad-band* Yagis, on the other hand, usually provide good color reception. Any antenna with *flat* response over the received channel, plus a noise-free signal, will deliver a good color picture.
If there are standing waves on the lead-in, the line can be cut to a critical length to obtain color reception.	**True for one channel. If more than one color station is to be provided for, this expedient often fails to give satisfactory reception on *both* channels.**	When standing waves are present on the lead-in, causing the length of the line to become a critical factor, the proper procedure is to repair or replace the front end to obtain proper impedance match to the lead-in. Remember that discontinuities in the lead-in *installation* can cause the line length to become critical, in spite of the fact that the front end may be accurately matched to the line impedance.
The bandwidth of the chroma bandpass amplifier in an (R − Y) (B − Y) receiver can be broadened beyond 0.5 mc to obtain more color detail in the picture.	**The assumption is true but the adjustment is a compromise of conflicting factors. (See discussion.)**	When the response of the chroma bandpass amplifier is increased substantially beyond 0.5 mc in an (R − Y) (B − Y) receiver, it will be noted that although chroma detail improves the trailing edges of objects in the picture (during color reception) develop horizontal streaks or spikes. These spurious spikes are due to crosstalk between the Y and chroma channels.
If the color-phasing control is adjusted correctly for reception on one channel, it will not require readjustment on other channels.	**True only in special cases. In general, it is necessary to readjust the color-phasing control when the receiver is switched to another channel.**	Readjustment is usually required because the antenna may have an upward-sloping characteristic on one channel and a downward-sloping characteristic on another. Discontinuities in the lead-in and impedance mismatch to the tuner often cause a change in the standing-wave pattern on the lead-in from channel to channel. The frequency response of the tuner may also differ from channel to channel. These variations cause a *phase shift* in the chroma signal, which may require readjustment of the color-phasing control to compensate for the shift.
The color picture tube is so sensitive to stray magnetic fields that setup adjustments must always be made if the receiver is moved to another place in the room.	**Sometimes true but not necessarily so. Whether purity is greatly affected depends upon local conditions.**	The amount of variation in stray magnetic fields about a room may be small or large in different situations. Some buildings contain extensive steel construction, while others have practically none. Stray magnetic fields are usually found in the vicinity of iron pipes, conduit, steam radiators and floor furnaces. No hard-and-fast rule can be laid down concerning stray magnetic fields in residences or shops.
Color TV is developing so fast that test equipment available today may become obsolete tomorrow.	**True only for certain special types of instruments. No matter what receiver designs are adopted, 90% of present-day equipment will always be essential.**	The vast majority of test instruments are designed for the NTSC signal, which *all* receivers process in one manner or another. Accordingly, the wide-band (4-mc) scope, NTSC color bar generator and standard sweep alignment equipment cannot possibly become obsolete. However, the white dot generator could become unnecessary if a one-gun color picture tube is finally perfected.
It is so difficult to learn about color TV that it is best to have nothing to do with it.	**A very short-sighted attitude. Operators of horseshoeing shops sometimes took a similar attitude toward the automobile back in 1912.**	It is no more difficult for a technician versed in black-and-white TV servicing to become proficient in color service than it was for radio technicians to master the new conceptions presented by black-and-white TV. Some who have cleared the new hurdle say that it is actually easier.
You can save yourself a lot of headaches by talking down color TV to your customers.	**This business practice is aptly termed "knocking yourself out." You might as well spend time each day tossing money out the window.**	Color TV servicing is a new high-profit market. People expect to pay more for color service. They expect the receivers to require more frequent attention. And surprisingly enough, in the present market, customers are not highly critical of reception quality. The only headache is the time and effort required to learn the new technology. *Don't be a buggy-whip peddler in the automobile era.* END

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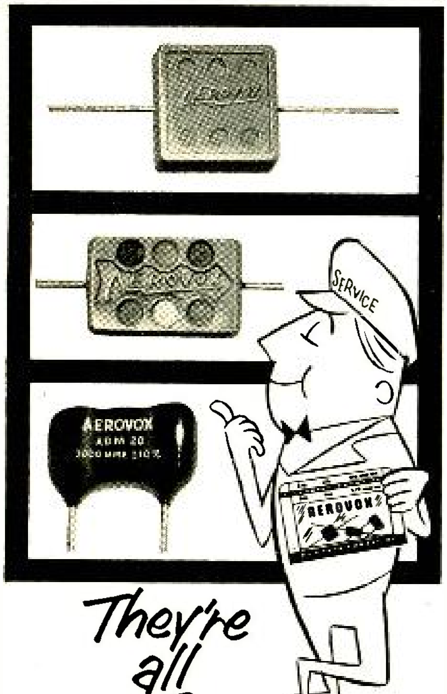

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NEW BEDFORD MASSACHUSETTS

tv dx

By ROBERT B. COOPER, JR.

IT took a little while, but it finally happened. F2 skip made the big jump across the United States, bringing what is probably the first reception of this type ever recorded on a transcontinental basis. The period of Jan. 1–9, 1958, saw transcontinental skip between such places as Nova Scotia, Maine, New York, Montreal, Pennsylvania and the western United States —Washington, Oregon and northern California. Although most reception consisted of video only, channel 2, some northern California dxers did manage to sneak in a few minutes of audio at reception peaks.

Eddie Albright of Medford, Ore., reports his first F2 on Jan. 9, between 1100 and 1430 PST of what appeared to be CKCW, Nova Scotia. The audio portion of Eddie's channel 2 was completely obliterated by amateur 6-meter stations in Ohio, New York, Pennsylvania and New England. Some of the longest 6-meter TVI we have heard of!

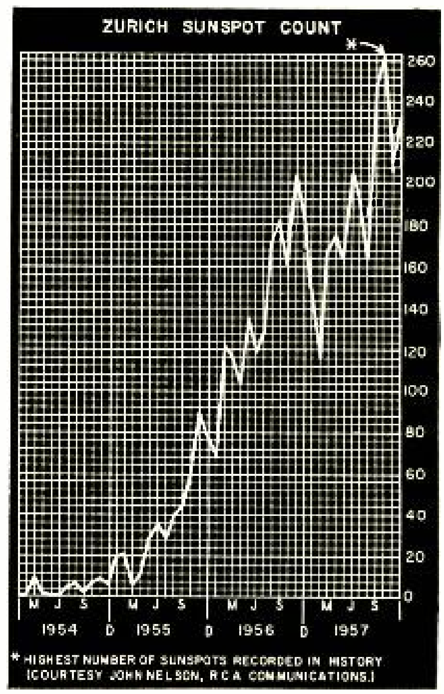
James Scalvini of Ferndale, Calif., fared somewhat better, noting channel 2 reception like clockwork every day Jan. 1–9, excepting Jan. 2, between 0900 and 1100 PST. Reception would last 15 minutes to over an hour. Video reception was very distorted with multiple ghosting, continually changing phase relationships, all of which made viewing bad.

Going from West Coast observers to Nova Scotia, Canada, dxer Ronald Boyd of Truro, Nova Scotia, has had some very good luck in logging a Russian channel 2 station, BBC channel 3 (on our channel 2) and many tentatively identified stations from Germany, France, Italy and elsewhere. Dx was peaking nicely during the first three days of this year, but dropped off considerably around the middle of January. Such reception is gone for US and Canadian observers until next fall.

From the looks of current sunspot count information, the best F2 TV dxing for the current 11-year sunspot cycle should have occurred during November, 1957, and January, 1958. The peak average spot count appears to have been reached and a gradual descent is expected for the next few years. European reception should be very good again this fall, however. Skip is reported to have reached as high as 70 mc between Europe and parts of the Atlantic coast on two occasions this past fall, the highest values ever recorded (see chart).

Looking from the other end, we have on hand a report from Murilo Rodrigo Marques Lopes, employed at Radio Free Europe, in Portugal. During the first weeks of November, 1957, Murilo reports strong but badly ghosted reception from what appears to have been WCBS-TV, New York; WGR-TV, Buffalo, and WGBH-TV, Boston, Mass. Dxer Lopes uses a dx setup worthy of the name, with complete switchable gear for all known world standards.

During the summer of 1957, frequent daily reception was noted from many European countries (on E skip), lots of good trops and now some F2. We hope to have Es reports from him this summer for a comparison between Es conditions on the two continents.



The Zurich number is compiled at the Federal Swiss Observatory and is a weighted figure representing the daily average number of sunspots observed each month.

E skip: Winter, 1958

Not to be left out, some E skip was reported during the first two months of this year, occurring for the most part during January. Jan. 3 appears to have been very good throughout the country. Dxer Ronald Boyd notes Jan. 3 as being on a par with anything seen at his location during the summer months. Es got as short as 430 miles for Ron (to Boston) while on the West Coast, KBOI-TV, channel 2, Boise, Idaho, was seen in Medford, Ore., by Eddie Albright, a short 330 miles for E skip. Such short skip is known as an occa-

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sional summer-time phenomenon, and is seldom noted in the winter.

February, 1958, has produced only one reported opening, occurring over a very southerly path from Malibu, Calif., to Harlingen, Tex., and Mexico City, Mexico. Mr. Jack F. Harris reports this skip during the evening of Feb. 8.

Although many brilliant auroral displays have been noted by visual observers, auroral dx on the television channels has been conspicuous by its absence. Again turning to Nova Scotia, Ronald Boyd of Truro notes identification of WSYR-TV, channel 3, Syracuse, N.Y., several times on Dec. 31, actually lasting all day from early morning (0630) till late evening. Another observation of daytime aurora (something which cannot be seen visually but must be tracked by radio reflection) occurred in the early morning of Jan. 1. CBFT, Montreal, was logged several times, with another patch of auroral skip around midnight. WBBM-TV, channel 2, Chicago, popped through on what appears to have been aurora-Es at midnight on the first. This picture was strong, although accompanied by violent fading and bad ghosting. We are still soliciting detailed reports of similar east–west hauls made during aurora.

A brilliant visual display on the evening of Feb. 10 and the morning of the 11th was reported as far south as Miami, Mexico, and Los Angeles. The same disturbance was also active in the southern hemisphere producing an Aurora Australis, seen over wide areas in the South Pacific. Dx reports for this period do not show any TV effects however.

Meteor-scatter dx

Ed Prond, Dolton, Ill., and John Cody, Middleton, Conn., are two dxers who don't quit just because E skip ceases to be a daily occurrence or trops drop below par. Both managed to add to their station totals during January. Dxer Prond added 4 stations and Cody a whopping 11 new stations, all logged via meteor scatter. If you are new to the dxing game, we suggest you consult back copies of the TV DX column for more information on meteor-scatter dxing.

In our January listing of total number of stations logged by dxers, and the *Over 50 TV DX Club*, some confusion has been reported by readers. When first writing to this column, please include a list of your totals, broken down channel by channel, of every station logged by you in your dxing career. Dates and times of these back loggings are not required, although helpful to us. Your initial report, to which we add your monthly reports, is kept on file. If you keep your monthly reports coming in on schedule, listing all dx seen over the 30-day period, your totals will automatically appear up to date and be complete in the once-a-year-totals listing.

In counting a station which has changed call letters, channels, locations, etc., we find the following method best. If the station in question changes channels (thus creating a new set of interference conditions), it is permissible to count the station as a new logging. Moving the transmitter location 10 miles or more also allows you to add the station to your log again. But mere changes in call letters, power increases, etc. do not constitute a new station.

Predictions

With the normal E-layer skip occurring in May and June, the chances for high-band burst reception (channels 7–13) is greatly increased when we have a strong E-skip opening coinciding with a strong meteor shower. With skip running as high as channel 6 (88 mc) over a 1,200-mile path, a meteor shower entering the E layer during the skip session may push burst reception into channels 7–13 with amazing frequency.

Before this reaches the newsstands, E-layer skip should be occurring on a fairly regular basis, providing dxers with frequent reception of low-band channels 500–1,500 miles distant. During the first two weeks of May, E skip is likely to occur from 1600–2100 local time. Moving on toward the end of May, Es follows no set pattern, occurring most anytime during the day and night. Watch vacant channels or those with fringe reception for signs of stations or interference from antenna headings not normally productive of a station. Reception via multihop E skip should be possible to Venezuela, Puerto Rico and Brazil during the second and third weeks of May, around 1700–2000 local time (channels 2–4). June and E skip are almost synonymous. Any time, any direction, any of the low-band channels the rule, not the exception.

Ground-wave reception increases greatly as the warmer months approach. With temperature inversions occurring almost daily, in the early morning and around sundown, general reception will probably increase 100 miles on low-band vhf, 150 miles on high-band vhf and 50–100 miles on uhf. Extra special long-range ground-wave conditions are usually signaled by approaching warm, moist fronts, moving eastward following a high-pressure area of dry air. Early morning and late evening are again the best periods of the day to try your hand at unusual extended ground-wave reception. East–west paths are normally most productive.

Report forms

This column, through RADIO-ELECTRONICS Magazine, provides free TV dx report forms or logging sheets to any observers requesting them. Your use of these forms will insure that we get all the essential information for each of your dx loggings. Simply address a 2-cent postcard to TV Dx Column, RADIO-ELECTRONICS Magazine, 154 W. 14th St., New York 11, N.Y. New report forms are sent upon receipt of completed monthly sets from you, the dxer. END

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TV Service CLINIC

conducted by

By ROBERT G. MIDDLETON
TELEVISION CONSULTANT

WE are getting many requests for data on dc restorers and how to add one to a TV receiver. Because of the interest shown in this circuit, we are presenting the basic facts here.

There are two types of TV receivers. One has dc coupling from the picture detector to the picture tube. This type of receiver does not use a dc restorer. Dc restoration is inherent in dc coupling. Most receivers fall into the second category and are ac-coupled from the picture detector to the picture tube. These receivers require dc restorers for good reproduction of dark night and bright daylight scenes. Without dc restoration, night scenes appear too bright and day scenes too dark. Moreover, dark lettering on white backgrounds and light lettering on dark backgrounds appear with severe background distortion and smear.

A dc restorer clamps the horizontal sync tips to a preset level determined by the setting of the brightness control and *reinserts the dc component* of the composite video signal. *It also does much more than this.* It restores all ac frequencies in the video signal from dc to 15,750 cycles.

Hence, the name dc restorer is an ultra-conservative term. It is like saying that a rich man smokes 50-cent cigars. He also drives a Cadillac and drinks vintage wines. A better name for a dc restorer would be a *low-frequency recovery device.* Note that dc is a very low frequency (zero frequency, to be exact). Hence, if we call a dc restorer a low-frequency recovery device, we include its function of reinserting the dc component—moreover, we recognize the ac recovery function of this modestly named device.

A basic dc restorer is arranged as shown in Fig. 1. It holds the horizontal sync tips at some dc voltage value. It does this on the basis of the low forward resistance of the restorer diode, which conducts on the sync tips. The restorer charges capacitor C, which then discharges slowly. So, the capacitor always shows a charge which is practically the same as the horizontal sync voltage during vertical retrace time. At this time, the peak-to-peak voltage of the sync pulses gives the actual dc level. Because the time constant of the R-C circuit is long, the horizontal sync does not "slump" or "grow" between vertical retrace intervals. This is clamp action. A "slump" or a "growth" in sync-tip level corresponds to distortion frequencies from zero to 15,750 cycles. Clamping eliminates this distortion.

The 100,000-ohm resistor in Fig. 1 reduces the restorer diode's load on the video signal lead. It works because it passes the 15,750-cycle sync pulses. The 100,000-ohm resistor works into the input capacitance of the diode. Accordingly, it gives a low-pass filter action where needed. The high video frequencies are not found across the diode. The restorer operates only on low video frequencies.

You will find elaborations of the Fig. 1 configuration, depending upon the

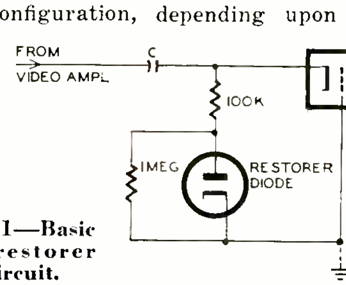

Fig. 1—Basic dc restorer circuit.

details of the picture tube input circuit. However, the basic principle is always as shown in Fig. 1. If you will take the time to understand its action, you will understand all dc restorer circuits.

Mixed-up colors

On an RCA CT-100 color receiver, large areas of red show as green, though small red objects appear OK. Afc and matrix are adjusted properly. Any suggestions will be appreciated.—J. H. C., Willowdale, Ont., Canada.

Your report does not describe the symptoms in detail. However, it would seem that the picture tube is not tracking. Tracking means the adjustment of screen and background controls so that a neutral gray screen is maintained over the normal signal range of a black-and-white picture. A gray screen must be maintained at any usable settings of the brightness and contrast controls.

Here are the important rules:

1. To correct a highlight tint, adjust the blue and green background controls.
2. To correct a lowlight tint, adjust the blue and green screen controls.

Two-set coupling

Two receivers are being operated from a coupler which seems to be defective. Horizontal bar interference appears on one of the receivers.—R. N. S., Crystal City, Mo.

If a receiver radiates considerably, the coupler must have sufficient attenu-

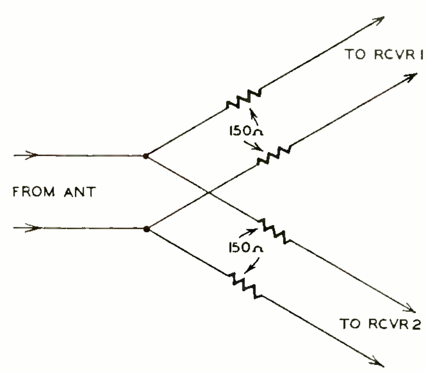

Fig. 2—This type of 2-set coupling reduces interference caused by radiation.

ation to kill the interference. A coupler made up from four 150-ohm resistors as shown in Fig. 2 is sometimes sufficient. However, if you still have noticeable interference, you must add H-pads in the receivers' lead-ins as in Fig. 3.

Vertical roll

A Zenith 23G22 has a tendency to roll vertically. I have replaced numerous components in the vertical oscillator and sync section, with no effect. The vertical hold is very touchy. What can you suggest?—B. S., Baltimore, Md.

Your report does not state whether the picture rolls up or down or both ways at different times. If the picture rolls down, the trouble is in the vertical oscillator. But, if the picture rolls up, the trouble can be in either the integrator section or the oscillator. When the oscillator drifts too far off frequency, even a strong vertical sync pulse cannot lock the sweep. On the other hand, a weak vertical sync pulse will not hold sync when the oscillator drifts slightly. This is a job for a scope. Check the vertical sync waveforms for

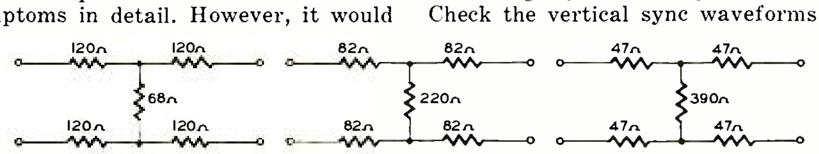

Fig. 3—H pads may be needed when coupling 2 sets to a single TV antenna to attenuate interference-causing radiation.

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peak-to-peak voltage. If these are correct, investigate the resistors and capacitors in the vertical-oscillator section—particularly those in the grid circuit.

Snowy picture

In a Philco 22B4002, code 140 TV receiver the picture is snowy on all channels. The antenna checks good, the tuner has been cleaned and appears to be normal, as well as the other stages in the receiver. Can you suggest the cause of this trouble?—D. S., Jr., College Park, Md.

There is a point in the early signal circuits at which the incoming signal is greatly attenuated and falls down to the noise level. Once this happens, subsequent amplification is useless, and all pictures become snowy. It is fairly easy to localize this type of trouble by pulling tubes and watching the picture. Start by tuning the receiver to a vacant channel. Turn up the contrast and volume controls to place considerable snow in the raster and noise in the sound. Then disconnect the lead-in. If there is little or no change in the noise level, the trouble is in the antenna. Try a pair of rabbit ears, or other antenna, for comparison. If there is a very noticeable drop in noise, the antenna is OK. Leave the antenna disconnected for the next tests. Pull the mixer. If there is a big drop in noise, the mixer is OK and the trouble is in the rf amplifier. But if there is little or no change in noise level, there is trouble in the mixer circuit. We know the oscillator is OK because you can get pictures. In exceptional cases, the trouble will be found in the first if amplifier stage.

Vertical instability

An Admiral 20X5B has intermittent vertical instability caused by a slight hum in the video which is not noticeable in the sound. Hum bars are noticeable only when the picture is momentarily off and carrier is on. Horizontal pulling varies from time to time. A scope shows 60-cycle hum as far back as the second if. I suspected that the lead-in cable might be picking up some ac, but another receiver works OK on the same cable. Overriding the agc bias with battery voltage does not help. I have checked the power supply. I'm about out of ideas on this one.—H. E. S., Bryan, Tex.

Since the hum is at 60 cycles, we can go immediately to the heater system. This is a job which should be done with a scope at the output of the video amplifier, to check the hum level while unplugging tubes right down the line from the front end. This will probably localize the trouble and simplify location of the faulty circuit. However, if you can unplug all the tubes and still have the hum, the heater voltage is getting into the signal through a leak. It could be a leak across a socket from heater to grid. This can be localized by disconnecting the heater line step by step, leaving the scope at the output of the video amplifier. END

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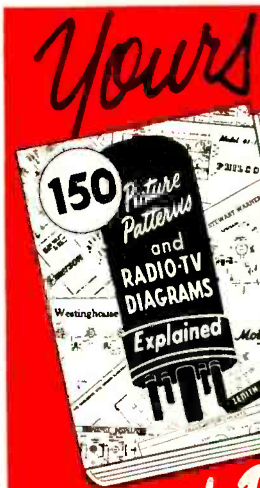

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SQUARE-WAVE GENERATOR

Simple 2-tube instrument delivers square waves at all frequencies between 10 and 180,000 cycles

By T. W. DRESSER

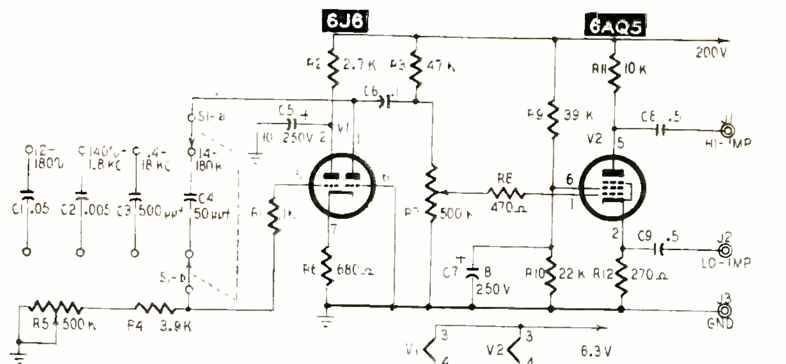
THE quickest and easiest way to check the performance of any amplifier (video, scope or audio) is by squarewave analysis. The method is rapidly increasing in popularity, but has been held back by the relatively high price of a suitable generator.

While circuits for home-built instruments have appeared, they usually do not extend beyond about 20 kc, limiting their use to audio amplifiers. For scope or video amplifiers, a range extending to 100 kc or more is a must.

This inexpensive unit will cover from 10 or 12 cycles up to 180 kc and can be built by the average technician. It has four ranges: 12–180 cycles, 140–1,800 cycles, 1.4–18 kc, and 14–180 kc. The generated square wave has a rise time of slightly over 0.5 μsec and a 12-volt peak-to-peak amplitude.

The circuit (Fig. 1) is essentially a cathode-coupled multivibrator. Components were chosen with a view to limiting the amplitude of the plate waveform. A dual triode is used rather than two separate tubes to obtain better symmetry of characteristics. The multivibrator's output is coupled to a 6AQ5 amplifier which provides both high- and low-impedance outputs.

I used a 10 x 5 x 2-inch chassis, but there is no reason why the unit could not be built into a small metal cabinet. A power supply delivering 200 volts dc at 50 ma and 6.3 volts at 2 amps is required. Calibration depends to some extent on the B-voltage and the unit's frequency range may vary if the B-supply voltage is different.



R1—1,000 ohms
R2—2,700 ohms
R3—47,000 ohms
R4—3,900 ohms
R5, 7—pot, 500,000 ohms
R6—680 ohms
R8—470 ohms
R9—39,000 ohms
R10—22,000 ohms
R11—10,000 ohms
R12—270 ohms
All resistors ½ watt 10%
C1—.05 μf
C2—.005 μf
C3—500 μμf
C4—50 μμf
C5—10 μf, 250 volts, electrolytic
C6—0.1 μf
C7—8 μf, 250 volts, electrolytic
C8, 9—0.5 μf
All capacitors 600 volts unless noted
J1, 2, 3—banana jacks
S1—2-pole 4-position rotary
V1—6J6
V2—6AQ5
Miscellaneous hardware

Fig. 1—Generator circuit. An external power supply is needed.

Square-wave generators can be divided into two types—those using a sine-wave generator followed by a clipper and amplifier, and the multivibrator type working as a relaxation oscillator. Any form of square-wave generator should have a balanced waveform—duration of pulses equal to time between pulses—so it can be used for beam switching on oscilloscopes and other purposes. Both types of generators will provide this, but a complicated circuit or carefully matched time-constant components are required.

Take extra care while wiring and see that all capacitors are kept well away from the chassis to keep stray capacitance down. Leads should be as short as possible and well away from the chassis. Mount the time-constant capacitors (C1, C2, C3, C4) directly on switch S1. Use the smallest-size capacitors available and on no account use metal-cased units. The potentiometers are carbon or composition types.

When wiring is finished and the circuit has been checked for errors, you are ready to check the generator. Connect its output to the vertical input terminals of a good oscilloscope—one that has reasonably flat response at high frequencies and a fast rise time—otherwise it will be impossible to make accurate tests.

Switch on the generator and scope. Now vary the sweep until only 2 or 3 cycles are visible on the screen. Then adjust R1 until a balanced trace (see Fig. 2) is obtained. Then check at with the generator set at 50 cycles, 10 kc and 100 kc. At these points the square wave should be a perfect figure without tilt, rounding or overshoots.

In use, the generator's output is connected to the input of the amplifier under test and a scope is placed across the amplifier's output. Departures from a square wave at the output are noted and the cause found and repaired.

In video amplifiers, if there is a falloff of lower frequencies or phase

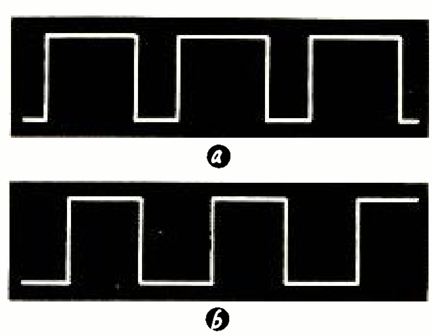


Fig. 2—Waveshapes at generator's output: a—unbalanced wave; b—balanced wave.

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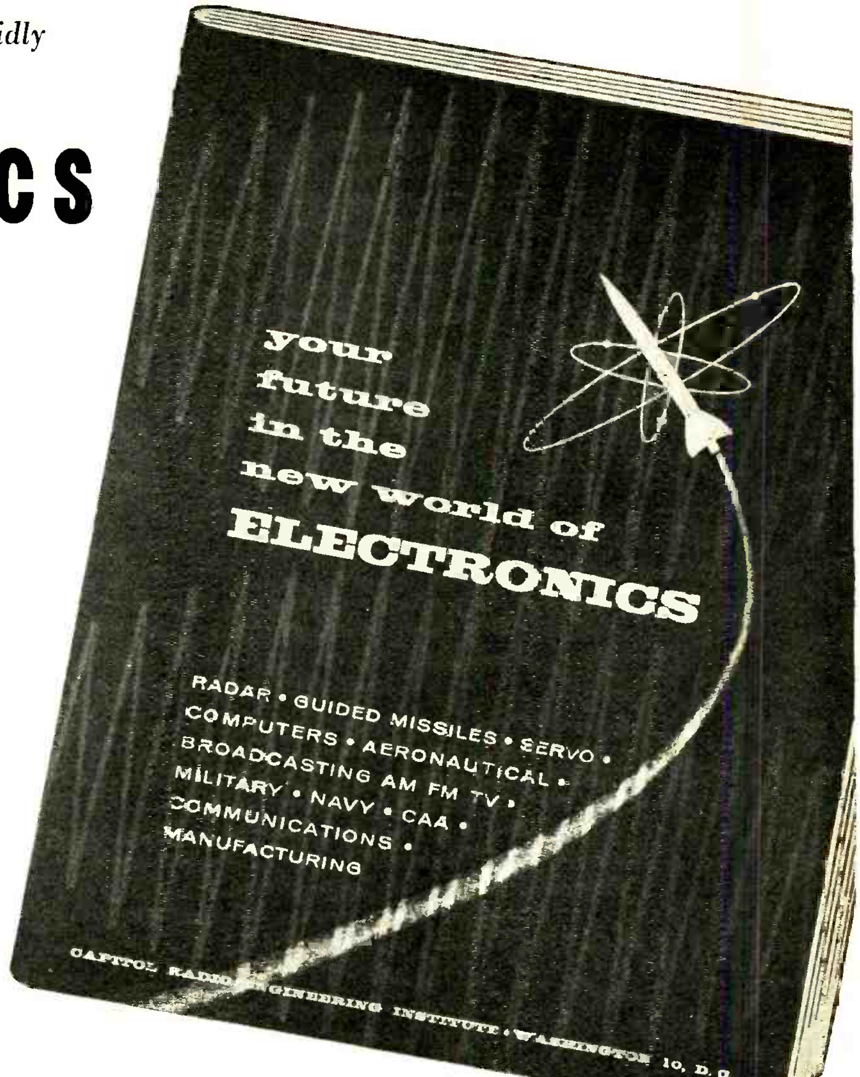

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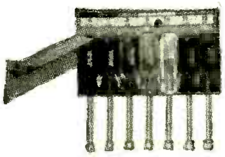

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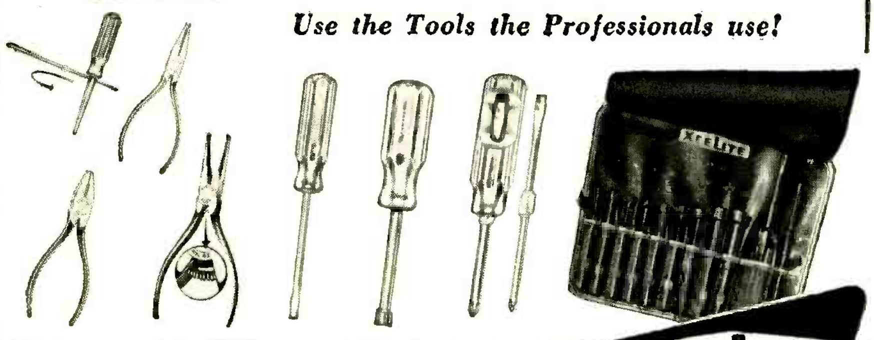

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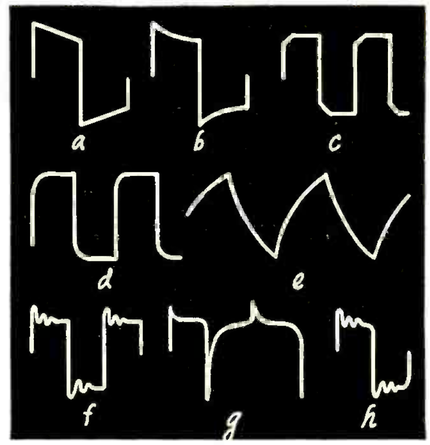

Fig. 3—Waveforms observed in amplifier troubleshooting: a, b, c—indicate a falloff of lower frequencies or phase shift with regard to higher frequencies; d—falloff in frequency response above 800 kc; e—falloff in frequency response around 200 kc; f, g, h—resonant peaks caused by misadjusted peaking coil, high wiring inductance or high-frequency leakage.

shift with regard to higher harmonics, the top of the wave, instead of being flat, will lean over and may even be concave as in Figs. 3-a, -b and -c. Fig. 3-d indicates a falloff in frequency response above 800 cycles and Fig. 3-e shows a similar condition at a lower frequency, around 200 cycles.

Resonant peaks result in the patterns shown in Figs. 3-f, -g and -h. This frequently indicates a misadjusted peaking coil, high wiring inductances or high-frequency leakages through gain controls or faulty capacitors.

While the unit is small and easy to build, don't think of it as a toy or something only for amateurs. It is intended for serious work and is probably as good for this purpose as many higher-priced more complicated equipment. It will have many uses in checking video and scope amplifiers and will prove just as valuable when that defective hi-fi amplifier comes into the shop. END

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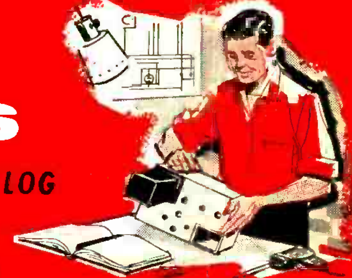

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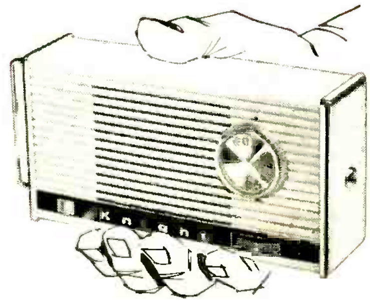

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SPOT-O-MATIC

With this signal generator, a flick of a switch spots the frequency you want—between 15 and 100,000 cycles

By I. QUEEN
EDITORIAL ASSOCIATE

THE R-C type of audio oscillator is well adapted to home construction because it is easily assembled and calibrated. This one has novel features not found in previous designs. Using only two tubes and no variable capacitors, it is easy to construct and takes up little space. It covers 15 cycles to 100 kc with plenty of output and low distortion. The most important feature is spot tuning, which makes many fixed frequencies available at the throw of one or more switches.

Fig. 1 is the complete circuit. V2 feeds back voltage to V1's grid through an R-C network. Oscillations occur at the frequency of the network. V2 is a cathode follower capable of high output at a low output impedance. Note how direct coupling eliminates components and, of course, improves frequency response. V2's cathode is well above ground, but so is its grid and there is no bias problem. The power supply is conventional and needs no description. It is a full-wave type that delivers about 135 volts at 20 ma to the oscillator.

From TV receivers we know that switch tuning is quick and convenient and that it eliminates human error. If you have occasion to use several frequencies during a test run or hi-fi measurement, you will appreciate this feature. It means that you can switch from one frequency to others and always return to the precise value you originally had.

There are three frequency switches, for 15, 25 and 60 cycles. Fortunately we are not limited to a single frequency per switch. Actually, combinations of the three may be switched in, the resultant being the sum frequency. For example, operating the first two switches (15 and 25 cycles) gives a 40-cycle output. With the three basic frequencies there are seven spot frequencies per decade. They are 15, 25, 40, 60, 75, 85 and 100 cycles, making a good distribution throughout the decade. The oscillator has a multiplying switch for ×1, ×10, ×100 and ×1,000; so you have a total of 28 spot frequencies, the highest being 100 kilocycles.

The frequency-coupling network is a bridged-T (see Fig. 2). Bridged-T oscillators generally have lower distortion than those based on the Wien bridge. Also, hum is lower because there is a common ground for both input and output.

Capacitors C_a and C_b control the

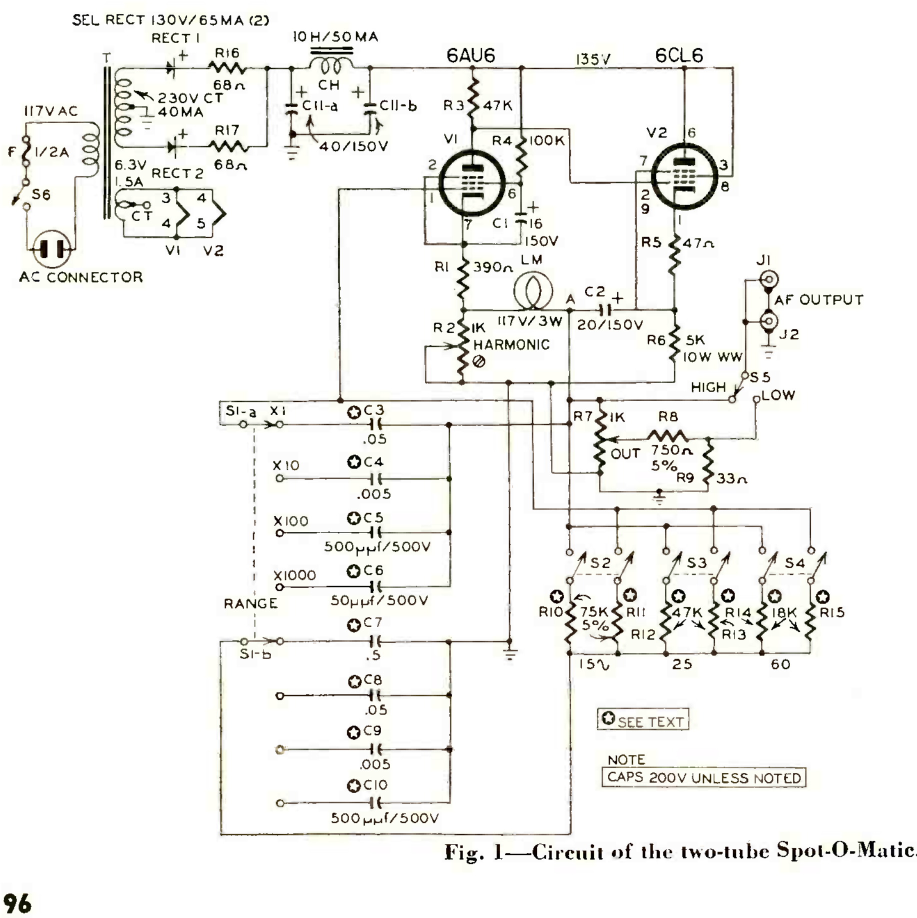

Fig. 1—Circuit of the two-tube Spot-O-Matic.

R1—390 ohms
R2—pot, 1,000 ohms, screwdriver adjust
R3—47,000 ohms
R4—100,000 ohms
R5—47 ohms
R6—5,000 ohms, 10 watts ww
R7—pot, 1,000 ohms
R8—750 ohms, 5%
R9—33 ohms
R10, 11—75,000 ohms, 5%
R12, 13—47,000 ohms
R14, 15—18,000 ohms
R16, 17—68 ohms
All resistors ½-watt 10% unless noted
C1—16 μf, 150 volts, electrolytic
C2—20 μf, 150 volts, electrolytic
C3, 8—.05 μf, paper
C4, 9—.005 μf, paper
C5, 10—500 μμf, mica, 500 v
C6—50 μμf, mica, 500 v
C7—0.5 μf, paper
C11—40-40 μf, 150 volts, electrolytic
All capacitors 200 volts unless noted
CH—filter choke, 10 h, 50 ma, 500 ohms (Triad C-3X or equivalent)
F—½-amp fuse
J1, 2—phono jacks
RECT 1, 2—selenium rectifiers, 65 ma, 130 volts (Federal 1002 or equivalent)
S1—2-pole 5-position rotary (1 position unused) (Centralab PA-1003 or equivalent)
S2, 3, 4—dpdt toggle
S5, 6—spst toggle
T—power transformer: primary, 117 volts; secondary, 230 volts ct, 40 ma; 6.3 volts, 1.5 amps (Triad R-29A or equivalent)
V1—6AU6
V2—6CL6
LM—3-watt 117-volt candelabra screw-base lamp (Allied Radio 52E354, GE type 3S6 or equivalent)
Socket, candelabra screw
Socket, 7-pin miniature with shield
Socket, 9-pin miniature with shield
Chassis, 2 x 7 x 7 inches
Fuse holder
Miscellaneous hardware

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CHART OF CAPACITANCES USED BY THE AUTHOR

Capacitor	Value and connection
C3	.05 μf
C4	.022 μf in series with .005 μf
C5	500 $\mu\mu$f
C6	47 $\mu\mu$f
C7	0.5 μf
C8	.05 μf in parallel with .001 μf
C9	.005 μf
C10	500 $\mu\mu$f in parallel with 36 $\mu\mu$f mica trimmer adjusted for optimum

frequency *range* which may be $\times 1$, $\times 10$, $\times 100$ or $\times 1{,}000$. C_b is always 10 times larger than the corresponding C_a. When the switch is thrown to the next higher range, the respective capacitors are one-tenth the value of those for the previous range. For any given range, resistors R_a and R_b are equal, and they select the actual frequency.

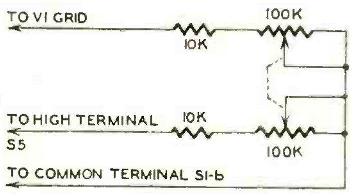


Fig. 2—The basic bridged-T frequency-determining R-C network.

A lower resistance means higher frequency. For the three spot frequencies we need three pairs of identical resistors.

Building the oscillator

The instrument is built into a 7 x 7 x 2-inch aluminum chassis. There is plenty of space for all components without crowding. The HARMONIC control is above the chassis, all others are on the front panel. The output jacks are mounted on the right of the chassis.

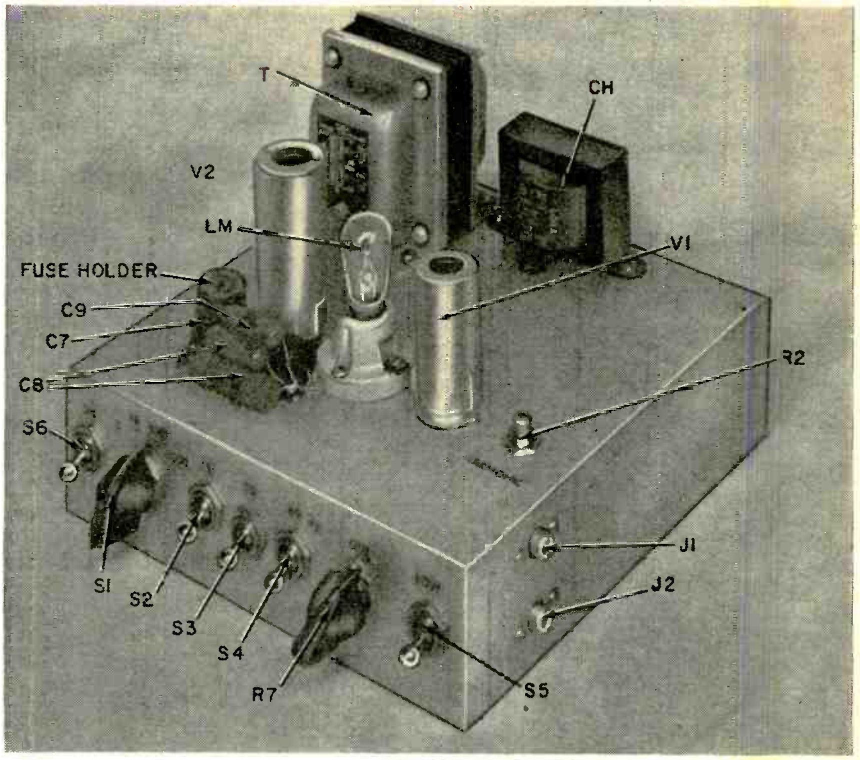
First mount the tubes, HARMONIC control, transformers, etc. Then assemble the power supply and check it.

Now you are ready for the frequency networks. Since the frequencies are fixed, it pays to spend a lot of time here to obtain accuracy. Commercial instruments are often rated at 5% maximum error but, if you have the time and patience, you can do much better. The plan is to go through your resistor and capacitor supplies and select the correct values by actual frequency measurement. The values designated on the schematic will provide the required frequencies quite closely, but if you have access to an oscilloscope, you can *select* components for higher precision.

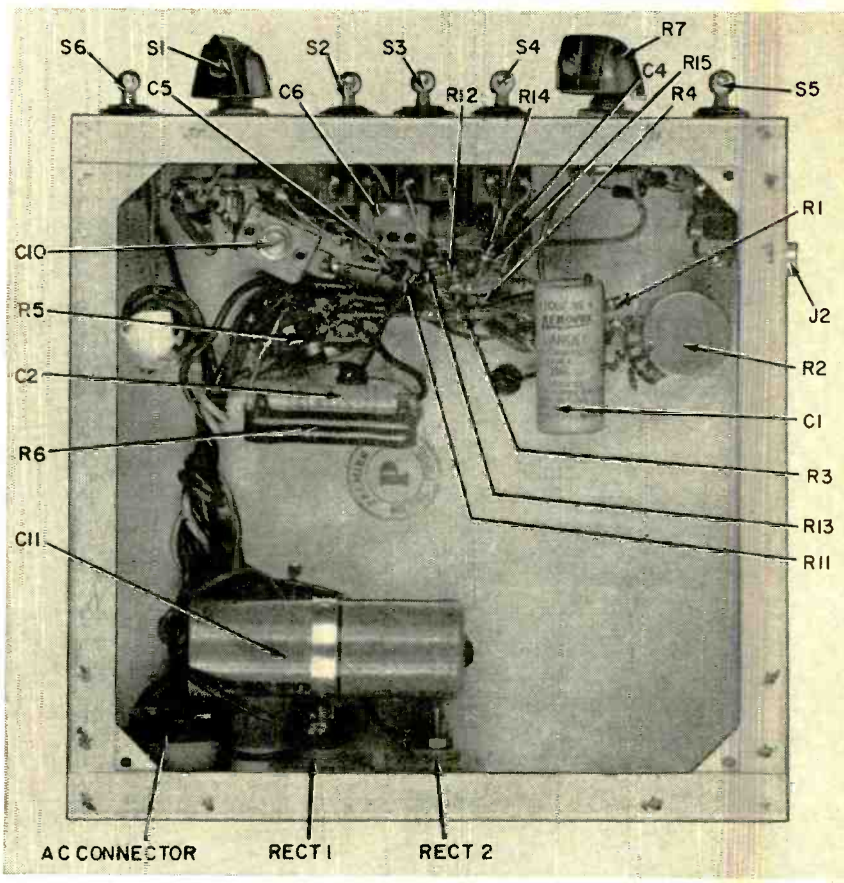
Few experimenters have access to a good capacitance bridge, and it is not needed. Use paper or mica capacitors throughout, not ceramic or electrolytic. The resistor pairs should be checked with an ohmmeter.

For the $\times 1$ range, you need a 0.5- and a .05-μf capacitor. (At this stage of the game it is wise to connect all components with clip leads, leaving the soldering until you have made the final selection.)

Using your ohmmeter, select a matched pair of resistors of approximately 18,000 ohms. Upon completing the network and connecting it to the oscillator, your scope should show a frequency of 60 cycles.* If the frequency is too high, larger resistors are needed or the value of the capacitors may be increased. That's why it is a good idea to have three or four capacitors and



All the Spot-O-Matic controls but one are mounted on the instrument's front panel.



Under the chassis. Note that the rectifiers and power supply filter capacitor are mounted away from the rest of the oscillator's circuitry.

*George Zwick, *Oscilloscope*, page 122 (Gernsback Library).

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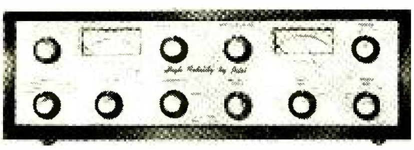

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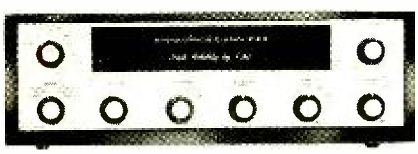

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resistors of each indicated value on hand. Select the units that give greatest accuracy.

Now pick a matched pair of 75,000-ohm resistors. Try various units from those you have to get as close to 15 cycles as possible. Repeat this with 47,000-ohm resistors to obtain 25 cycles. If this frequency does not make an easily recognized pattern when compared with line frequency, try switching on 15 and 25 together. The 40-cycle pattern is easier to recognize. If the 15 and 40 networks are accurate, the 25 must also be.

Select a .05- and a .005-μf capacitor for the $\times 10$ range. Don't forget that the larger unit is always C_b and connects to switch S1-b. With these capacitors the frequency must be 10 times larger and the amplitude must remain unchanged. Be guided by these facts: If one or both capacitors are too large, your new frequency will be lower than it should be. If the amplitude is too high, the *ratio* of C_b to C_a is too great.

Amplitude adjustments

For example, suppose we have completed the $\times 1$ range. Switch in any desired frequency in the band, say 40 cycles. Connect to the scope and set the sweep so that a single cycle appears. Thus, the sweep frequency is also 40 cycles. Now switch to the $\times 10$ range. You should observe 10 complete cycles on the scope. Furthermore, the amplitude of the range-2 pattern should be *identical* with range-1 signal.

Let us say that you are not too lucky (or perhaps you are very fussy). You feel that the range-2 amplitude is larger than that of the first. Furthermore, the frequency is a little too low and you want improvement. To raise the frequency we need lower capacitance (the resistors have been selected once for all ranges and should not be disturbed). The larger amplitude of range 2 shows that the ratio C_b/C_a is too large. Therefore, we select another (*smaller* value) for C_b. For extra-high precision you may even have to make a new selection for *both* capacitors.

Your labor can be eased with the help of another oscillator to compare frequency. Otherwise, simply set your scope for a complete cycle on one range, and look for 10 complete cycles on the next higher range. Use a minimum (preferably zero) sync signal during this measurement. For high accuracy, the patterns should remain stationary *without* aid of sync.

To arrive at the correct value of capacitance or resistance, you can add units in parallel or series as required. The chart shows the particular shunt and series capacitor arrangements I used. The same method applies, of course, to the resistors. I find that heat applied to a resistor can often raise its resistance several percent. If you have a resistor that is slightly low, apply a hot soldering iron to its leads. The resistance will rise appreciably, and in most cases will fall on cooling but leave a net rise. For this reason keep hot soldering irons away from the resistors once you have the correct value.

Note that C7, C8, and C9 are mounted above the chassis. The other capacitors are below.

Final steps

After completing the instrument, connect its output to an oscilloscope. Note that J1 and J2 are tied together. Thus you may use one as signal source for an amplifier, and the other may be used for monitoring voltage or waveform. As the HARMONIC control (R2) is set toward zero resistance, no oscillation will occur. At maximum a distorted wave will be observed and, as the resistance is lowered toward midrange, the wave clears up. At about a 3-volt output, it should be a good sine wave but distortion will be still lower as R2 is decreased further.

S5 controls the output amplitude. In one position the *maximum* is about 3 volts (depending upon R2's setting). In the low position, the *maximum* is about 100 mv. R7 is a variable output control.

Because of low output impedance, the voltage does not drop much when a load is connected. For example, if you adjust for 2 volts open-circuit, a 600-ohm load will reduce it to 1.5 volts.

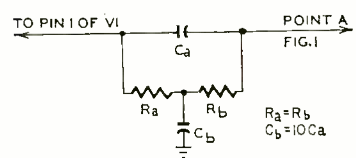

Fig. 3—A few additional parts and you've added a useful variable frequency circuit to the unit.

If you wish to add other basic frequencies or perhaps to substitute frequencies for those listed, the resistances must be changed. The required resistance may be calculated from the following simple formula:

$$\frac{f}{1,100} = R$$

where R is in thousands of ohms and f is the basic frequency (in the lowest range). Capacitors are as specified previously. Thus, for 55 cycles you need a pair of resistors, each 20,000 ohms. Of course this is the *approximate* value. The exact resistance is indicated by your oscilloscope as already described, and it requires careful selection of resistors.

Also, you may wish to add variable tuning. Since capacitance is fixed for any given range, the resistance must be varied. For the variable element use a dual potentiometer, each unit 100,000 ohms with logarithmic taper (see Fig. 3). The fixed resistors are limiting elements. To use the variable tuning, switch off all fixed frequencies and switch in the dual potentiometer instead. This feature was actually included in an earlier model of the Spot-O-Matic, but was abandoned in favor of greater simplicity. END

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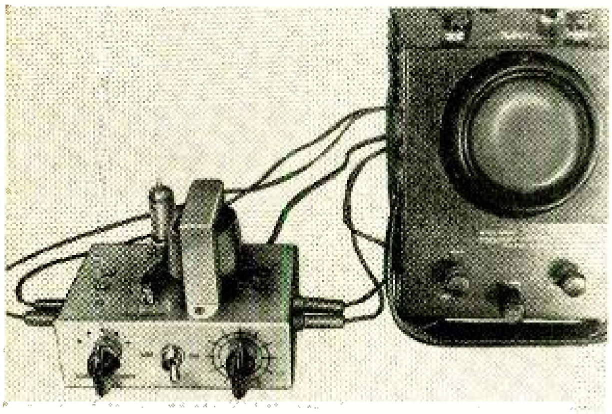
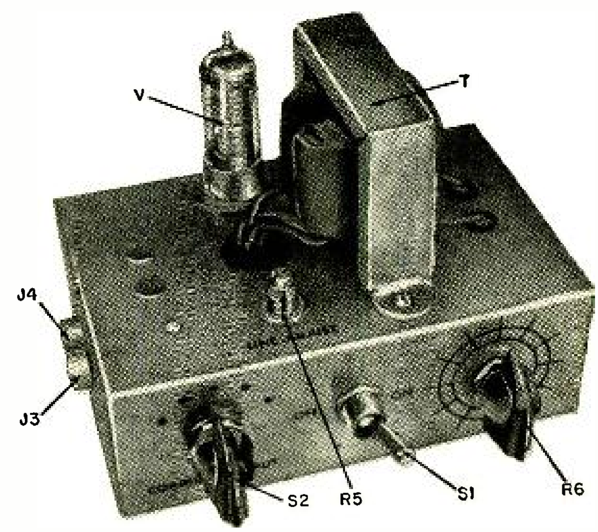
An Inexpensive Scope Calibrator

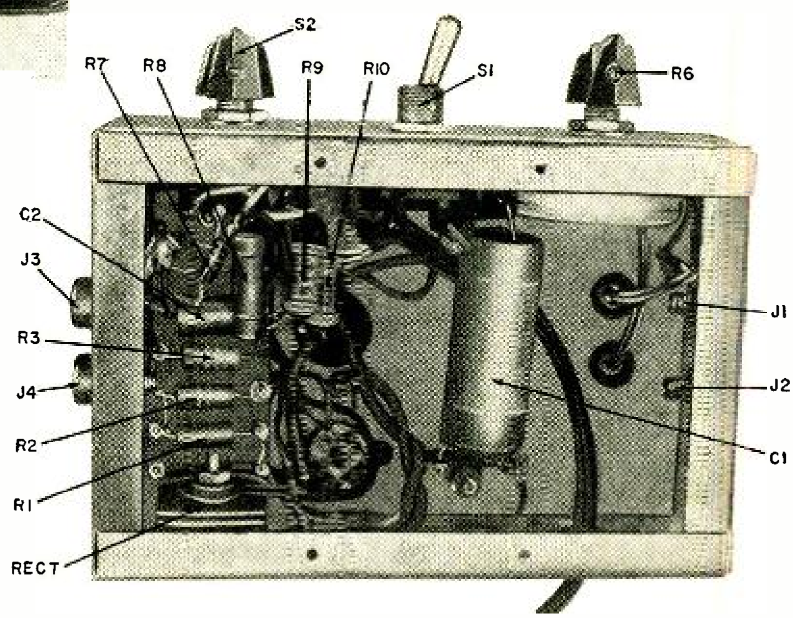
A range of .01 to 100 volts peak-to-peak with an accuracy of 5% makes this unit a valuable addition to your test equipment

By JOSEPH CHERNOF





Top view

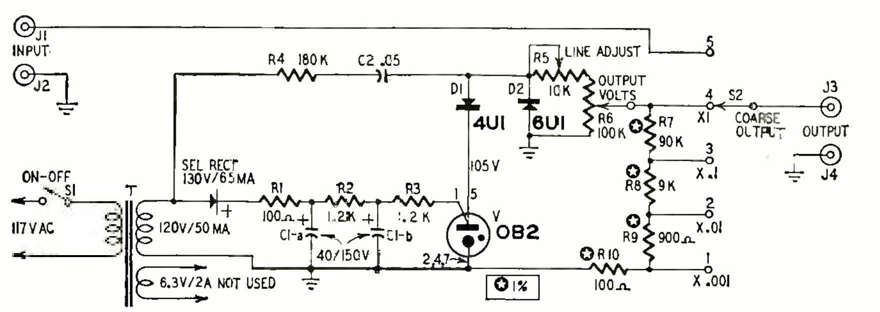


With a little crowding size could be cut in half.

IF amateurs and experimenters were polled as to what they consider the most important single difference between an inexpensive oscilloscope and its high-priced laboratory brother, the hands-down winner would probably be a built-in calibrator circuit. To be truly useful, the calibrator should provide a continuously variable output over a wide range with a reasonable degree of accuracy. It should also be small and compact so it can be used with a scope without increasing workbench clutter. Such a unit is described in this article.

The scope calibrator operates from the 117-volt line. It has a useful output from below .01 volt to 100 volts peak to peak. With normal values of ac line voltage, output voltage accuracy should hold to within 5% after calibration. Accuracy depends on the care used in selecting the voltage-dividing resistors used in the COARSE OUTPUT switch network.

There are three front-panel controls. One, the COARSE OUTPUT switch, is a decade attenuator that provides four ranges of output voltage. The second, the OUTPUT VOLTS control, provides a continuous linear adjustment of the calibrator output voltage. The third control is an ON–OFF switch. Two pairs of banana jacks on the unit's side panels provide input and output terminals. The signal input terminals replace the scope's vertical input terminals for all test-lead connections. The signal output terminals are connected to the scope's vertical input terminals. For normal use of the scope, the fifth position of the output attenuator control provides a direct



R1—100 ohms
R2, 3—1,200 ohms
R4—180,000 ohms
R5—pot, 10,000 ohms, screwdriver adjust with locknut
R6—pot, 100,000 ohms, linear taper
R7—90,000 ohms, 1%
R8—9,000 ohms, 1%
R9—900 ohms, 1%
R10—100 ohms, 1%
All resistors ½ watt
C1—40-40 µf, 150 volts, electrolytic
C2—.05 µf
*D1—4U1, International Rectifier selenium diode
*D2—6U1 International Rectifier selenium diode
(D1, D2 mounted under terminal board)
J1-4—Banana jacks
RECT, selenium 130 volts, 65 ma
S1—spst toggle
S2—1-pole 5-position rotary
T—Power transformer: primary, 117 volts; secondary 120 volts, 50 ma; 6.3 volts, 2 amps (Merit P-3045)
V—0B2
Case, 6 x 6 x 4 inches, socket, 7-pin miniature
miscellaneous hardware
* *Available from: Radio Shack, 167 Washington St., Boston 8, Mass.*

Circuit of the scope calibrator.

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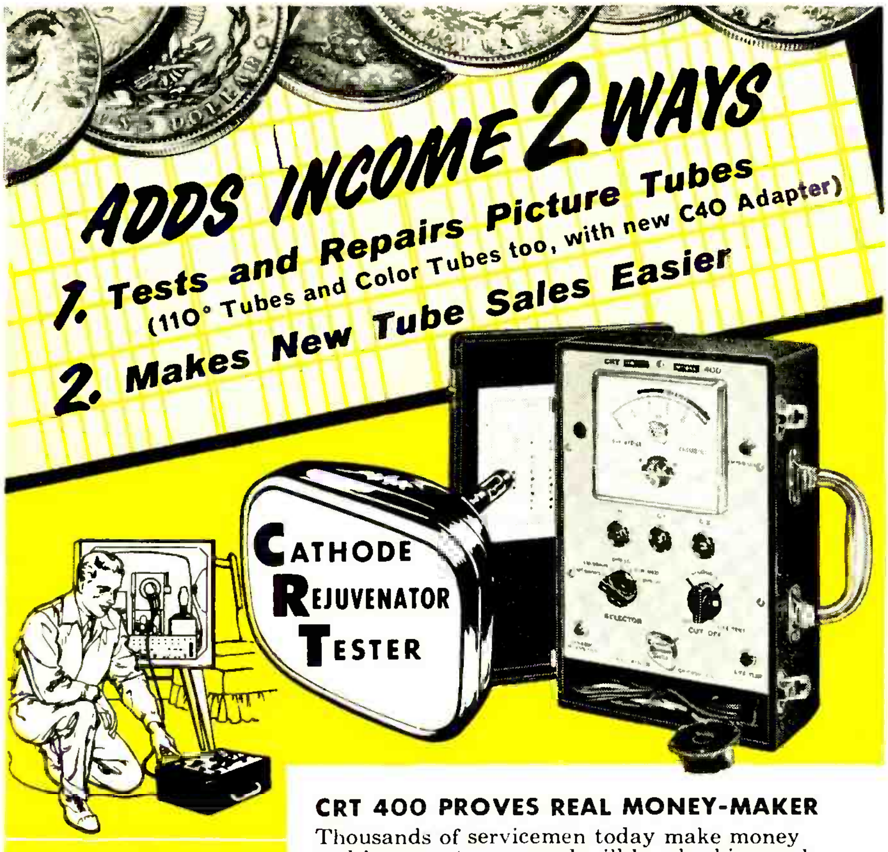

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connection between the input and output terminals. This effectively removes the calibrator from the scope's input so a signal from a circuit under test can be observed. Additional utility and flexibility can easily be incorporated by adding an extra pair of input terminals connected to a sixth position of the output attenuator switch. (You would need a six-position rotary switch instead of the five-position unit used.) This would let you monitor two separate circuits without moving test leads around.

The unit's circuit is shown in the diagram. A rectified dc output voltage is filtered through R1, R2, R3, C1-a and C1-b. R1 is a current-limiting resistor, included to prevent damage to the selenium rectifier by the initial surge of charging current drawn by C1. Resistors R1, R2 and R3 are also used in conjunction with V1, an OB2, to provide a regulated 105-volt dc output.

Clipped output

The transformer's 120-volt output is also applied to the calibrator's voltage-dividing resistors. Diodes D1 and D2 limit the applied voltage to a 105-volt peak-to-peak value. D1's cathode is biased with 105-volt regulated dc from V1 so that it will conduct when voltages exceeding 105 are applied to its plate. Thus, peak voltages higher than 105 are effectively clipped. Likewise, D2's plate is connected directly to ground so that all negative values of instantaneous ac voltage will also be clipped. The output of these clipping circuits is a semi-square wave with a constant 105-volt peak-to-peak value.

This constant output voltage is applied to the output attenuating circuits, consisting of potentiometer R5, potentiometer R6, and the COARSE OUTPUT switch resistors R7, R8, R9 and R10. Values for these resistors have been chosen so that the variable output voltage from R6 can be multiplied by attenuation factors of 1, 0.1, .01 and .001. R7, R8, R9 and R10 should be held to tolerances of 1% for best calibration accuracy.

The initial calibration procedure is short and sweet. Connect an accurate vtvm to output terminals J3 and J4, turn the calibrator unit on and set OUTPUT VOLTS potentiometer to the maximum voltage setting. Set COARSE OUTPUT switch to its ×1 position. The vtvm should indicate approximately 105 volts peak to peak. Vary R5 until the output voltage reads exactly 100 peak to peak. Tighten the shaft locknut.

The unit is now ready to use. It can be mounted on top of your scope or bolted to its side. The components will fit into a much smaller case if size and portability are important. If the unit is mounted on top of the oscilloscope, size would not be a major factor, and a 6 x 4 x 4-inch metal case, finished to match your oscilloscope, will provide an attractive housing for the calibrator. END

New Tubes & Semiconductors

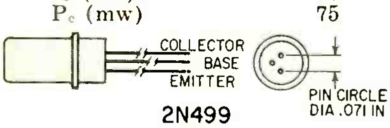
THIS month has turned out a large group of new units. Among them are two MADT transistors, a test picture tube for 110° deflection systems, a high-fidelity output tube and a group of 50-watt power transistors.

2N499

A micro-alloy diffused-base germanium transistor intended for use as a power oscillator or power amplifier at frequencies up to 100 mc. Polarities are similar to those of p-n-p transistors. Power gain is typically 10 db at 100 mc. Typical power oscillator output at 100 mc. is 35 mw.

The maximum ratings of this Philco transistor are:

V_{CB}	− 30
V_{CE}	− 18
V_{EB}	− 0.5
I_C (ma)	− 50
P_c (mw)	75



2N499
2N504

2N504

The 2N504 is a hermetically sealed germanium MADT (*M*icro-*A*lloy *D*iffused-base *T*ransistor) field-flow transistor designed for use in if amplifiers. Its maximum frequency of oscillation is at least 50 mc. Polarities are similar to those of p-n-p junction transistors.

Maximum ratings of this Philco unit are:

V_{CB}	− 35
V_{CE} (I_B = 0)	− 25
V_{EB}	− 1
I_C (ma)	− 50
P_c (at 25°C) (mw)	50

8YP4

This lightweight (2-pound) 8-inch rectangular picture tube is designed as a universal check tube for TV receivers

using 110° picture tubes. The tube has a conventional base and comes with an adapter to match the button base of most 110° tubes. It has a 6.3-volt 600-ma heater which is also designed to operate satisfactorily in 450 ma heater strings. It is made by Sylvania.

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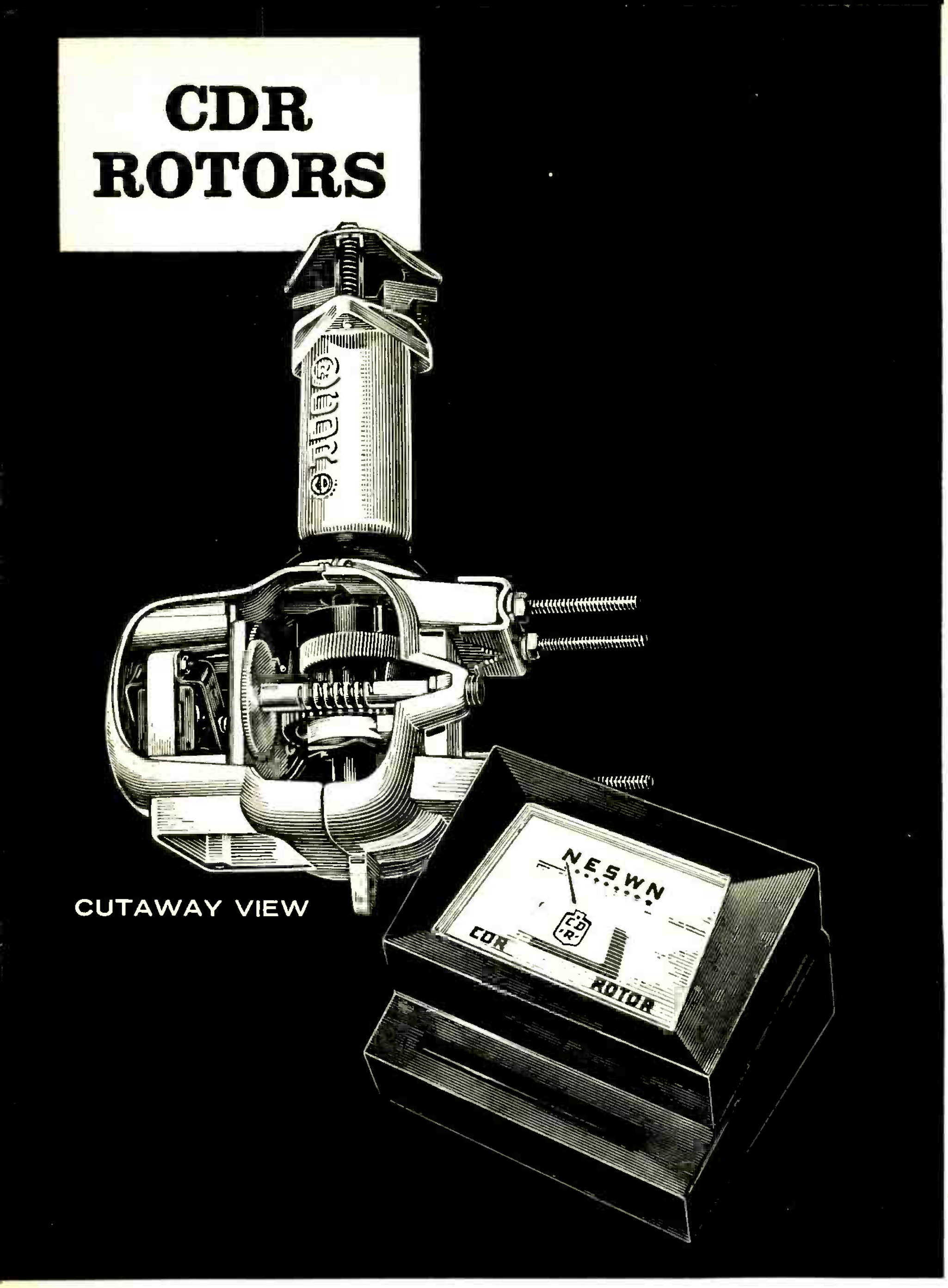

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CDR
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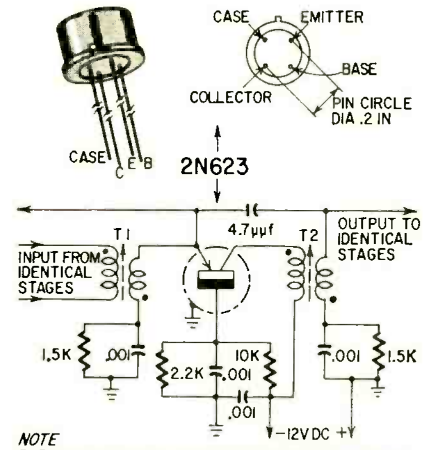
2N623

A high-frequency diffused-base germanium transistor that enables high gain at frequencies ideal for television if amplifiers, radio rf amplifiers and vhf oscillators. Featuring a 200-mc typical maximum frequency of oscillation and a 90-mc typical alpha-cutoff frequency, this p-n-p transistor delivers



NOTE
T1,T2-PRI: 21T N°30; SEC: 2-3/4 T N°30 WOUND OVER BOTTOM END OF PRI ON 1/4 IN DIA FORM

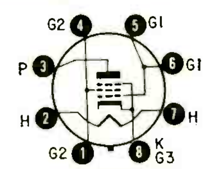
50-db gain at 1 mc and 13-db gain at 50 mc. In the 43-mc if amplifier circuit (see diagram) the Texas Instruments 2N623 provides 15-db typical gain and 20-mw output.

Maximum ratings of the unit are:

V_{CBO}	− 30
V_{CEO}	− 15
V_{EBO}	− 1
P_{total} (mw)	40

7027

A high-perveance beam power tube designed specifically for use in push-pull power amplifier circuits of high-fidelity audio equipment. Featuring high power sensitivity and high stability, the 7027 can deliver high power at low distortion. Double-base pin connections for both grids 1 and 2 provide for flexibility of circuit arrangement and cool operation of the grids, which minimizes reverse grid current.



7027

Typical operating values using this RCA tube in an Ultra-Linear output circuit are:

V_P	410
V_{g2}	see note
Cathode bias resistor (ohms)	220
Peak af (g1 − g1) (volts)	68
Zero-signal cathode current (ma)	134
Maximum-signal cathode current (ma)	155
Effective load resistance plate to plate (ohms)	8,000
Total harmonic distortion (%)	1.6
Maximum-signal power output watts	24

NOTE: g2 voltage is obtained from taps on the primary winding of the output transformer. The

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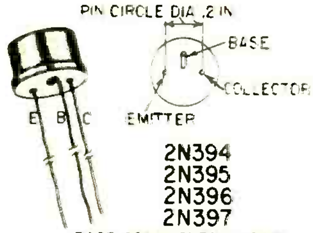
taps are located on each side of the center tap so as to apply 48% of the plate signal voltage to g2 of each tube.

2N394, 395, 396, 397

These germanium p-n-p alloy-junction high-frequency switching transistors are intended for military, industrial and data-processing applications where



BASE CONNECTED TO CASE

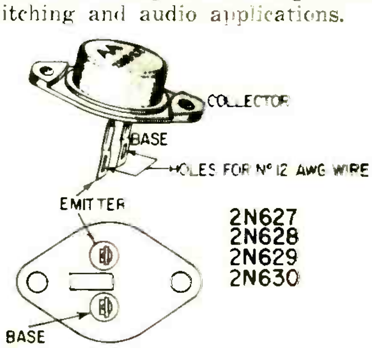
high reliability and extreme stability of characteristics are of prime importance.

Maximum rating of these General Electric transistors at 25°C are:

	2N394	395	396	397
V_{CE}	−10	−15	−20	−10
V_{CB}	−10	−15	−20	−10
V_{EB}	−10	−10	−10	−10
I_c (ma)	−200	−200	−200	−250
$P_{average}$ (mw)	150	150	150	150
Alpha-cutoff freq (mc)	5.5	7	7	10

2N627, 628, 629, 630

Germanium p-n-p alloy junction power transistors capable of handling high wattages at high voltage. Collector electrode is connected to the case. Units are designed for high-current switching and audio applications.



COLLECTOR CONNECTED TO CASE

Maximum ratings of these Motorola transistors are:

	2N627	628	629	630
V_{CB}	40	60	80	100
V_{CE}	30	45	60	75
I_c (dc) (amps)	10	10	10	10
P_c (base temp 30°C) (watts)	50	50	50	50

END

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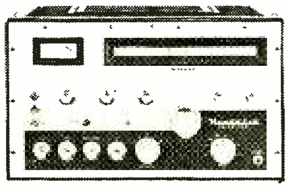
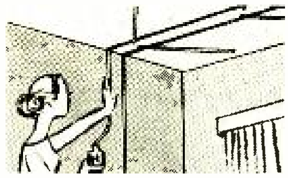
new Devices

HAM RECEIVER KIT, *Mohawk model RX-1.* Wide-band slide-rule type vernier tuning. Covers amateur bands from 160–10 meters. External receiver-powered converter accommodations cover 6 and 2 meters. Front end pre-assembled, wired and aligned. Double-conversion if at 1682



kc and 50 kc. 5 selectivity positions from 5 kc to 500 cycles. Bridged T-notch filter for maximum rejection. Built-in 100-kc crystal calibrator. 10-db signal-to-noise ratio at less than 1 μu input. 15 tubes.—**Heath Co.,** Benton Harbor 20, Mich.

INDOOR ANTENNA, *Perma-Tena.* Two continuous foil strips are glued to ceiling and connected to an antenna wall out-

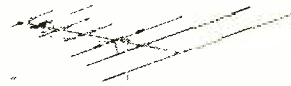


let. Elements are extended from both sides of ceiling strips and secured with conductive cement. When painted over, antenna becomes invisible. Kit includes compass for proper orientation, conductive paint and materials, wall outlet, wall and conductive cement, applicator and other necessary material.—**K & K Research Development Co.,** P.O. Box 925, Hawthorne, Calif.

FRINGE-AREA TV ANTENNA, *Satellite-Helix.* 28 elements. Front-to-back voltage ratios:

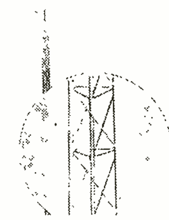
15 to 1 (low band), 18 to 1 (high band). 300-ohm impedance, balanced sleeve dipole system.—**JFD Electronics Corp.,** 6101 16th Ave., Brooklyn 4, N. Y.

TV ANTENNA, *Dura-Gold Corvette.* Deep fringe-area, all-channel type (2–13). Metal ele-



ments covered with vinyl plastic to protect against corrosion.—**Clear Beam Antenna Corp.,** Canoga Park, Calif.

ANTENNA TOWER, *No. 25.* General-purpose communications and heavy-duty TV type. 12 ½-inch equilateral triangular design. Uses 1¼-inch heavy-gauge tubing for side rails and zig-zag solid steel cross bracing. Self-supporting to 50 feet or



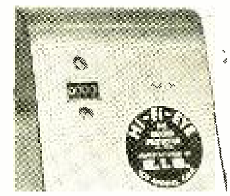
guyed to 150 feet. Hot-dipped galvanized or enamel finish.—**Rohn Manufacturing Co.,** 116 Limestone, Bellevue, Peoria, Ill.

LOW-LOSS SWITCH, for antenna systems, *TACO model 823.* Miniaturized unit 1¾ x 1¾ inches. Mounted in gold anodized case. Slide switch presents 300-ohm impedance for maximum energy transfer. Dpdt type unit used for switching between two antennas at receiver.—**Technical Appliance Corp.,** Sherburne, N. Y.

AUTO RADIO ANTENNA, *model JA-7 Bullet.* Chrome, die-cast swivels for vertical or 45°, angle mounting. 3-section telescoping mast extends to 57

inches.—**Tenna Manufacturing Co.,** 7580 Garfield Blvd., Cleveland 25, Ohio.

STYLUS-USE TIMER, *Hi-Fi-Eye.* When connected in parallel with record changer or turntable, automatically indicates how many hours it has been in use. Lets you know when to



change stylus.—**Electronic Instruments Service,** 8907 S. Vermont Ave., Los Angeles 44, Calif.

VARIABLE ATTENUATORS. *Model AV-50* (illustrated) has

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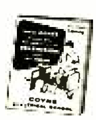

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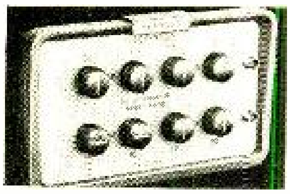
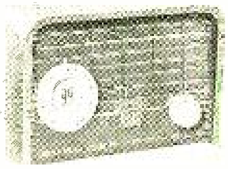


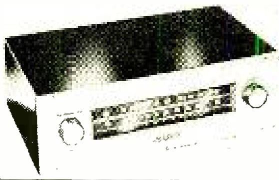
50-ohm characteristic impedance; *AV-75* has 75-ohm characteristic impedance. Both provide 0–62.5-db attenuation in 0.5-db steps. Operates from dc–500 mc.—**Jerrold Electronics Corp.**, 23rd & Chestnut Sts., Philadelphia 3, Pa.

UHF CONVERTER, *model 99R.* 3-section tuner with dual input section. Single-knob tuning of



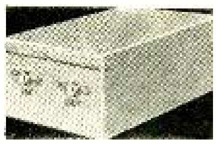
channels 14–83. 300-ohm impedance.—**Blonder-Tongue Laboratories Inc.,** 9-25 Alling St., Newark 2, N. J.

AM-FM TUNER, *model LT-25.* FM section: response within 1 db from 20–20,000 cycles; output



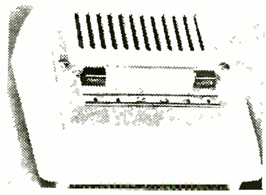
level for 100% modulation is 2.5 volts; afc and afc defeat; Armstrong circuit with limiter and Foster-Seeley discriminator. AM response 20–5,000 cycles, within 3 db. Built-in AM and FM antennas.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

REVERBERATION UNIT, *model U-2.* Used as link between basic amplifier output and input



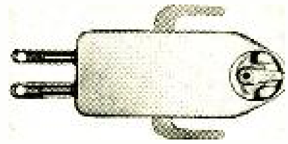
of any auxiliary amplifier and speaker combination. Gives illusion of presence without necessity for two sources of program material.—**Ultron Co.,** 7943 Haskell Ave., Van Nuys, Calif.

TRANSISTOR INTERCOM, *Centrum.* Two 4.5-volt batteries power unit. Standard set consists of master station, substa-



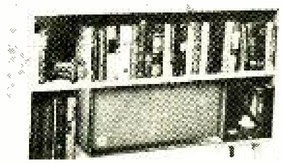
tion and 20 yards of cable. Up to 3 additional substations may be added.—**Reeves Equipment Corp.,** 10 E. 52 St., New York.

HI-FI PHONO CARTRIDGE.



Magneto-dynamic type. Moving magnet armature made of ferrite material and magnetized perpendicularly to its axis. Response from 10–20,000 cycles within 2 db. Output 3.5 mv at 10 cm/sec velocity. Lateral compliance greater than 5×10^{-6} cm/dyne. Vertical tracking force 5 grams.—**North American Philips Co. Inc.,** High Fidelity Products Div., 230 Duffy Ave., Hicksville, N. Y.

SPEAKER ENCLOSURES. *Model RJ/8* (illustrated), de-

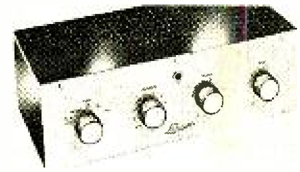


signed for 8-inch speakers, fits in single shelf of standard bookcase. *RJ 12-S:* double-shelf model for 12-inch speakers. *RJ/12-F:* floor model for 12-inch speakers. *RJ/Super 8:* ready-to-play system consisting of RJ/8 enclosure equipped with Wharfdale Super 8/FS/AL speaker. Unfinished birch and finished in mahogany, walnut or blond.—**R-J Audio Products Inc.,** 80 Shore Rd., Port Washington, N. Y.

FLEXICONE. Helps improve speakers. Lowers cone resonance 10–40 cycles. Gives soft, permanently flexible, outer-edge cone suspension. Comes in do-

it-yourself kit with instructions. —**Howard Re-Cone Service,** 824 Kennedy St. NW. Washington 11, D. C.

12-WATT AMPLIFIER, *model LA-22.* Response 30–20,000 cycles



within 1 db at rated output. Less than 1½% IM distortion. Hum level 60–80 db below full output. 5 inputs including tape head. Equalization, loudness, treble and bass controls.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

30-WATT AMPLIFIER, *HF-32,* kit or wired. Response within

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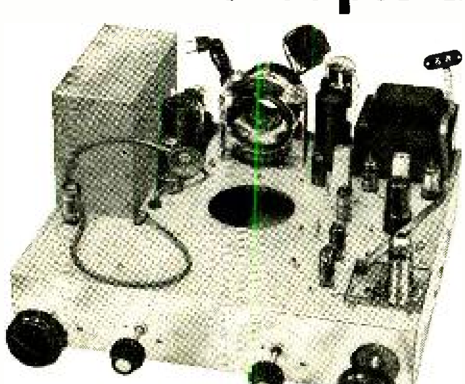

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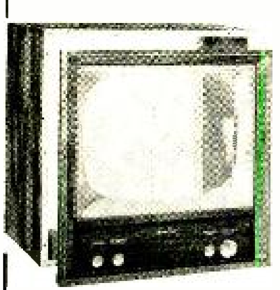

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The Progressive Radio "Edu-Kit" was specifically prepared for any person who has a desire to learn Radio. The "Edu-Kit" has been used successfully by young and old in all parts of the world, by many Radio Schools and Clubs in this country and abroad. It is used for training and rehabilitation of Armed Forces Personnel and Veterans throughout the world.

The Progressive Radio "Edu-Kit" requires no instructor. All instructions and parts are included. Every step is carefully explained. You cannot make a mistake.

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You begin by examining the various radio parts included in the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set, you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer, and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

In order to provide a thorough, well-integrated and easily-learned radio course, the "Edu-Kit" includes practical work as well as theory; troubleshooting in addition to construction; training for all, whether your purpose in learning radio be for hobby, business or job; progressively-arranged material, ranging from simple circuits to well-advanced topics in Hi-Fi and TV. Your studies will be further aided by Quiz materials and our well-known **FREE** Consultation Service.

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In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book.

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You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of troubles in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the Dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course but I found your ad and sent for your Kit."

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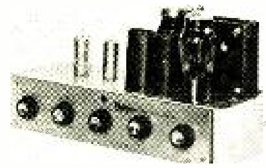
PROGRESSIVE "EDU-KITS" INC. 497 Union Avenue, Dept. 141G, Brooklyn 11, N.Y.

0.1 db from 15–30,000 cycles at any level from 1 mw–and 30 watts. Harmonic distortion below 1% within 1 db of 30 watts. 4, 8 and 16-ohm outputs. Inputs for magnetic phono, tape head, mike, high level (TV, tuner, aux). Equalization, level, loudness, bass, and treble controls. Rumble and scratch filters.—**Electronic Instrument Co., Inc., EICO,** 33-00 Northern Blvd., Long Island City 1, N. Y.

DUAL-CHANNEL AMPLIFIER, *Dual-Amp.* Input separated by electronic divider circuits into low-frequency and high-frequency components. Variable

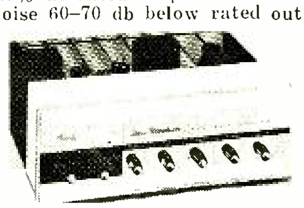


crossover between 100 and 4,000 cycles. Low-end amplifier rated at 24 watts, high end at 6 watts. Separate volume controls for each.—**Transvision Inc.,** New Rochelle, N. Y.

HI-FI AMPLIFIER, *Mini-Fi model KN-510.* 10 watts. Response within 1 db from 20–20,000 cycles at full output. Harmonic distortion less than 2%. IM distortion less than 3%. Inputs for magnetic phono, crystal or ceramic phono, tuner,

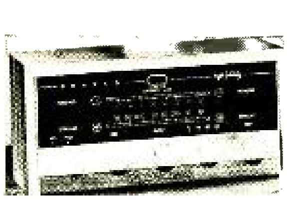
auxiliary equipment and tape head. Bass, treble, volume, equalization selector and rumble filter. Outputs for 4-, 8- or 16-ohm speakers and high-impedance output for tape recorder.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

STEREO AMPLIFIER, *model SR 17-17.* Combines 2 preamps and 2 power amplifiers on single chassis. Power output 17 watts each section. Harmonic distortion less than 0.5% at rated output. IM distortion less than 1.5% at rated output. Hum and noise 60–70 db below rated out-



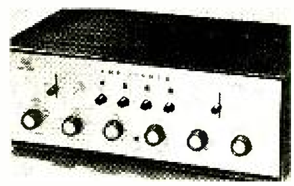
put. Response within 1 db from 20–15,000 cycles. Inputs for tape decks, tape recorders, phono cartridges and auxiliary. Compensation, balance, bass, treble, volume and contour controls.—**Sargent-Rayment Co.,** 4926 E. 12th St., Oakland, Calif.

FM–AM TUNER AMPLIFIER, *model AT-130.* Sensitivity: FM, 5 µv for 20-db quieting; AM, 25 µv per meter. Selectivity: FM, 220 kc at 3 db point; AM, 9 kc at 6-db point. Hum level 60 db below maximum output. Amplifier response within 0.5 db from 20–20,000 cycles. Harmonic distortion: FM, 1%; AM, 2.5%. Built-in antennas. Treble, bass, loudness, function selec-



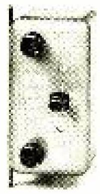
tor, and tuning controls. Tuning indicator. Inputs for tape or phone. Multiple speaker outputs.—**Granco Products Inc.,** 36-07 20th Ave., Long Island City 5, N. Y.

STEREO MASTER CONTROL UNIT, *model 400:* 16 inputs, arranged in 8 pairs.—Low level, tape, mike, monitor, tuner, aux 1 and aux 2. 4 outputs. Push-button input selector, equalization and output selectors, volume, balance, loudness, bass and treble controls. Response uniform from 20–25,000 cycles.



Distortion less than 0.15% for 2-volt output. Crosstalk, 60 db down.—**Fisher Radio Corp.,** 21-21 44th Dr., Long Island City 1, N. Y.

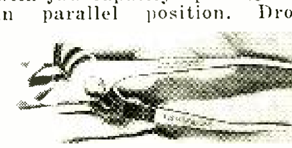
ADJACENT-CHANNEL TRAP, *Filter Matic.* Hi-Q traps and bandpass filters remove adjacent-channel TV interference. Units for all vhf channels available.—**Benco Television**



Associates Ltd., 27 Taber Rd., Rexdale, Ontario, Canada.

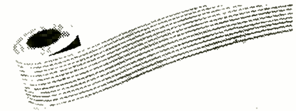
PANEL MOUNTING KIT. Accessory kit to be used with the Dynakit preamp. Includes brass escutcheon plate, pair of nickel-plated mounting brackets and hardware. Lets user mount preamp on panels up to 1⅛ inches thick.—**Available from Dynakit distributors.**

MULTIPURPOSE PLIER, *Channellock No. 426.* 6½ inches long with thin jaws. For use in hard-to-get-at places. 5 adjustments with jaw capacity up to ⅞ inch in parallel position. Drop-



forged; full-polished finish.—**Champion DeArment Tool Co.,** Meadville, Pa.

POLYSTRIP CABLE, multiconductor flat cable for use in electrical and electronic equipment. Available in widths up to 51 conductors. Consists of flat copper ribbon .0015 inch thick and



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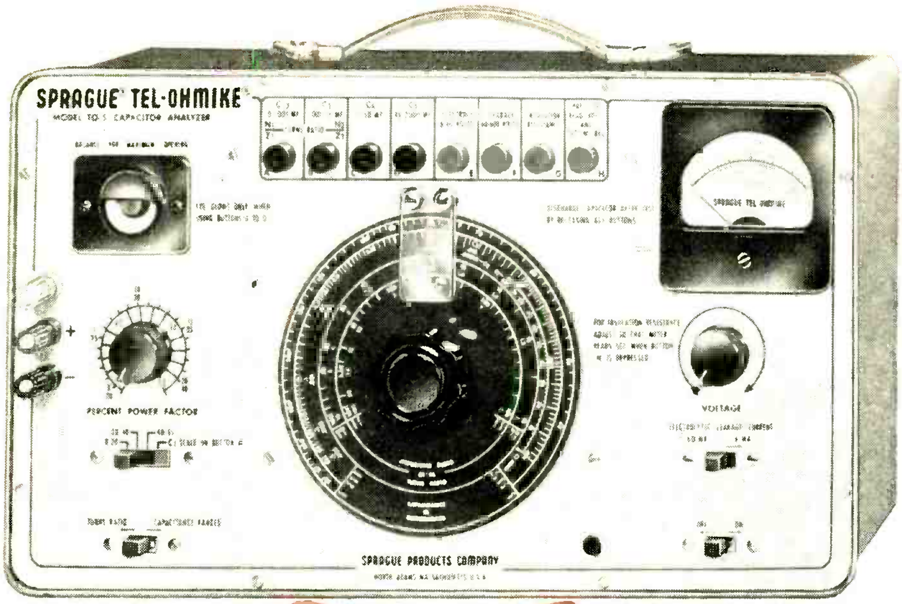

NEW TO-5 TEL-OHMIKE® capacitor analyzer

measures all 4 . . . plus

1 CAPACITANCE	2 POWER FACTOR	3 LEAKAGE CURRENT	4 INSULATION RESISTANCE	extra feature TURNS RATIO
Measures up to 2000 µf in five overlapping ranges . . . including an accurate 1 to 100 µµf range, exclusive with Sprague.	Power factor of electrolytic capacitors is measured by the highly accurate bridge method. Reads up to 55% in three ranges for convenience in measurement.	Leakage current of electrolytics is measured directly on the meter, with exact rated voltage up to 600 v. applied from continuously adjustable power supply. Two ranges—0-6-60 ma.	Insulation resistance of paper, ceramic, and mica capacitors is read directly on meter . . . up to 20,000 megohms.	In addition to its function as a complete capacitor analyzer, the TO-5 also measures the turns ratio of power and audio transformers.

The NEW TO-5 TEL-OHMIKE Capacitor Analyzer is one of the fastest and surest ways of measuring . . . capacitance, power factor, leakage current, insulation resistance, and turns ratio. This compact, easy-to-use instrument has the highest accuracy of any instrument of its type available to the service trade.

New jumbo dial makes meter reading easy. Special color-keyed pushbuttons permit instant range selection . . . and allow automatic safety discharge of capacitors after testing. Magic-eye tube simplifies bridge balancing for capacitance and power factor measurements.

SEE THE NEW TO-5 TEL-OHMIKE IN ACTION . . . AT YOUR DISTRIBUTOR!

This 4-in-1 test instrument is only 8⅞" high, 14⅝" wide, and 6⅛" deep . . . weighs a mere 12½ pounds. The complete price for . . .

MODEL TO-5 (115 VAC/50-60 cy) . . Only **$83.90 net**

Also available: Model TO-5X for 115-230 V/25-60 cy. . . $89.90 net
Model TP-5RM for rack mounting . . . . . $93.90 net

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.030 inch wide encased in plastic insulation. Each conductor rated at 1 amp.—**International Resistance Co.**, 401 N. Broad St., Philadelphia 8, Pa.

TUNABLE RF COILS. Encapsulated units cover a range of 0.1–10,000 μh. *Series 1*, 13/32-inch diameter, 7/8 inch long, 0.1

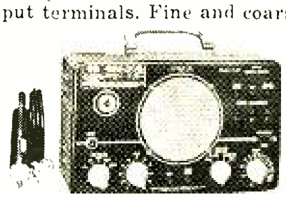
to 22 μh. *Series 2*, 17/32-inch diameter, 1 inch long, 33–10,000 μh. *Series 3*, 11/32-inch diameter, 5/8 inch long, 0.1–15 μh.—**Vanguard Electronics Co.**, 3384 Motor Ave., Los Angeles 34, Calif.

POTENTIOMETER KIT, *Trimit*. 25-turn pots; screwdriver-adjust; self-locking shaft. For vertical and horizontal hold circuits. Gives service technician greater range of adjustment. Introductory kit contains 5 assorted carbon elements, 5 clip-on adapters which fit chassis holes, and instruction sheet.—**Bourns Laboratories, Inc.**, P. O. Box 2112, Riverside, Calif.

REPLACEMENT FLYBACKS. *HVO 100* replaces G-E RTO-161. *HVO-160* for Zenith S-24978. *HVO-162* for G-E RTO-183.—**Merit Coil & Transformer Corp.**, 2027 Sherman St., Hollywood, Fla.

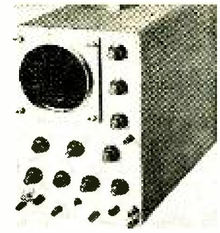
RF SIGNAL GENERATOR KIT, *model G-30*. 8 bands cover 160 kc-240 mc. To 120 mc in fundamentals. Rf output exceeds 100,000 μv. 400-cycle audio output approximately 15 volts.—**Paco Electronics Co.**, Div. Precision Apparatus Co., Inc., 70-31 84th St. Glendale, L. I., N. Y.

SIGNAL-TRACER KIT, *model Z-80*. Handles all receiver or amplifier signal levels, rf or af. High-gain amplifier for rf and af investigation. High sensitivity for direct pickup of broadcast signals at receiver antenna input terminals. Fine and coarse



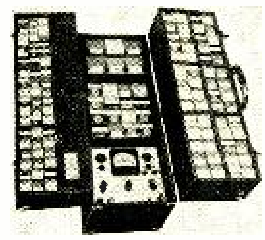
attenuators. Visual and audible signal indicators and output terminals for use with scope or vtvm. Noise test, wattmeter and test amplifier circuits.—**Paco Electronics Co., Inc.** Div. of Precision Apparatus Co. Inc., 70-31 84th St., Glendale 27, N. Y.

DC SCOPE KIT, *model OP-1*. Dc-coupled amplifiers and dc-coupled C-R tube unblanking. Triggered sweep circuit operates on either internal or external signals and may be ac- or dc-coupled. Sweep frequencies provided by switch-selected base rates of 2 and 0.2 msec/cm, and 20, 2 and 1 μsec/cm in conjunction with continuously variable 10-to-1 multiplier. 5ADP2 flat-face scope tube. Edge-lighted grid screen. Vertical attenuator has 12 positions and is calibrated in volts per cm. Horizontal sweep calibrated in time per



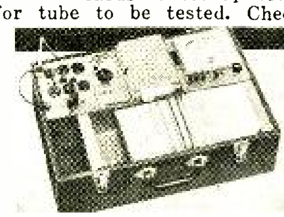
cm. Pre-wired terminal boards used for critical circuits.—**Heath Co.**, Benton Harbor 20, Mich.

CADDY TESTER has tube and rectifier checker built into tube and tool caddy. Leatherette-covered case with compartments



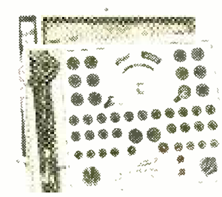
for tubes and tools.—**Vis-U-All Products Co.**, 303 Fuller Ave. NE, Grand Rapids, Mich.

AUTOMATED TUBE TESTER, *Cardamatic model 121*. Uses prepunched cards to set up tester for tube to be tested. Checks



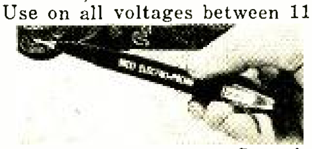
for mutual conductance, gas, grid emission, interelement shorts and leakages. Comes with cards for approximately 325 tubes.—**Hickok Electrical Instrument Co.**, 10531 Dupont Ave., Cleveland 8, Ohio.

TUBE TESTER, *Fast-Check model FC-2*. Two controls to set. Checks for quality, interelement shorts and leakage, gas content



and life expectancy. 7-pin and 9-pin straighteners mounted on panel.—**Century Electronics Co. Inc.**, 111 Roosevelt Ave., Mineola, N. Y.

POCKET TESTER, *Electro-Probe*. Checks for live outlets and determines if voltage is present at fuses, sockets, switches, lines and terminals. Use on all voltages between 110



and 500 ac or dc.—**Superior Instruments Co.**, 2435 White Plains Road, New York 67, N. Y.

END

All specifications given on these pages are from manufacturers' data.

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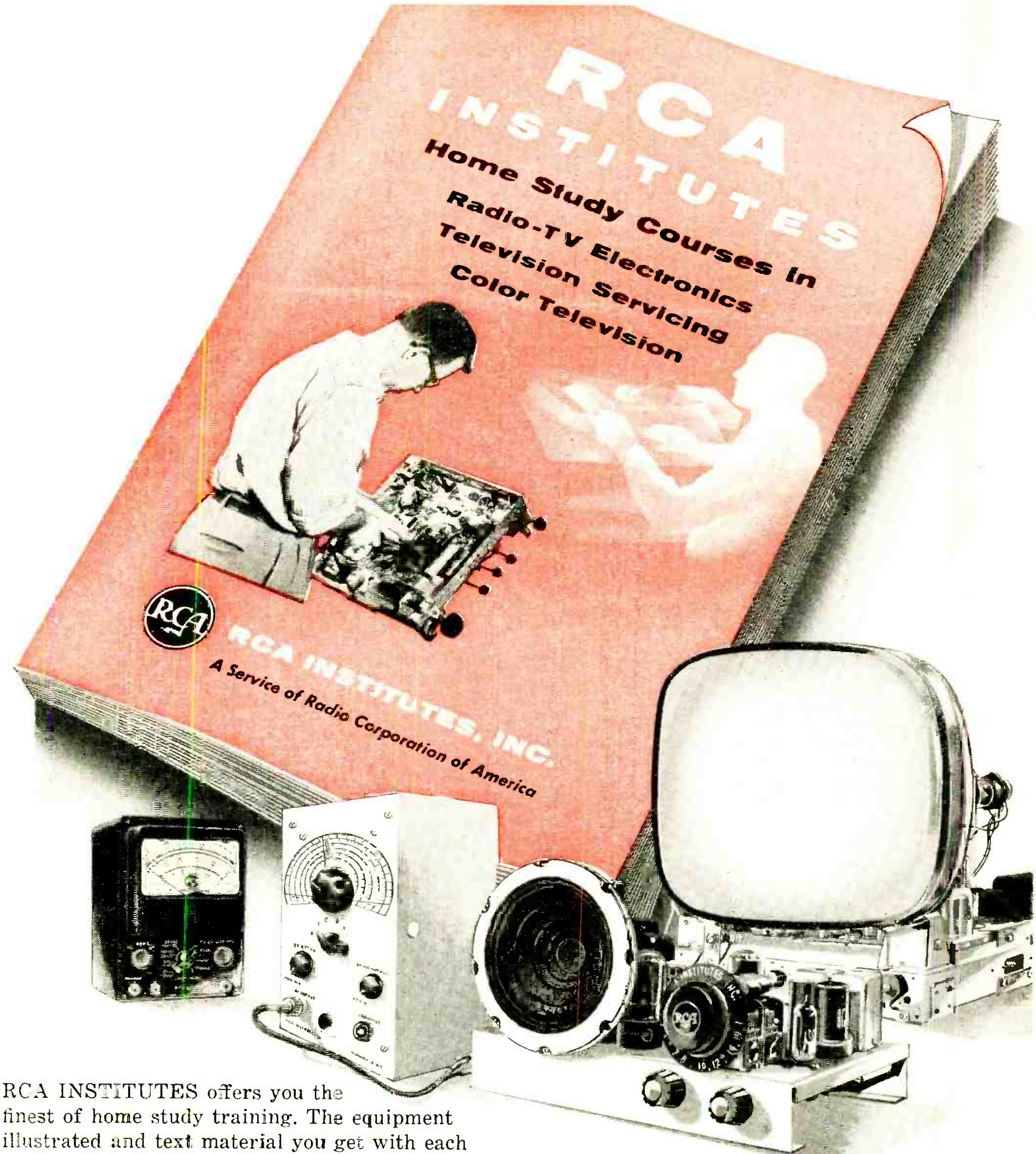

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Whatever the choice may be — tape, record, or good old fashioned AM/FM radio, straight or multiplexed — Madison Fielding is the design center of any stereo system. Complete control and amplifier facilities for both monaural and stereophonic sound are built into the perfectly matched Series 330 AM/FM Stereophonic Tuner and Series 320 40-watt Stereophonic Amplifier.

Series 330 Tuner:
Two complete ultra-sensitive tuners on one compact chassis for either AM or FM reception individually, or, with a turn of a switch, both signals can be made available simultaneously. Multiplexed output is provided for by use of one adapter.

Series 320 40-watt Amplifier:
In addition to individual controls for each channel, the unit features a Master Volume Control, which controls both levels simultaneously for stereo. When used monaurally, it will serve as a complete electronic crossover system to feed separate woofer and tweeter.

For further information, write to:

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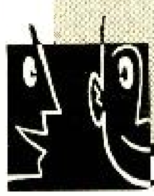
Technicians' News



NEW ASSOCIATION FORMED

A group of television technicians have banded together to form the Television Electronic Service Association of Central Missouri. Officers of the association are: Vernon Towner, Towner Radio & TV, Jefferson City, president; Al Idle, A & B Radio & TV, Jefferson City, vice president; John Reinsch, TV Service Center, Jefferson City, secretary-treasurer; Dennison Houghton, Peoples Radio Co., Columbia, director. Additional directors are to be appointed.

LESA FORMS

West Branch, Iowa, reports the organization and incorporation of the Linn Electronic Servicemen's Association (LESA).

The group plans to promote and maintain a high standard of ethics among retail electronic service technicians and dealers.

LESA officers are: Dick Reeder, president; Marvin Kirkpatrick, vice president; Tom Cours, secretary; George Rizzio, treasurer, and Louis Guetzko, Ralph Brink and Eugene Stick, directors.

LICENSE SUSPENDED

In the first action of its kind, the TV Board of Examiners of the City of Long Beach, N. Y., suspended the TV technician licenses of Norman Litman, Samuel Kaperstein and Bart Randazzo, operators of Melody Mart.

The board's decision states that these licensees had deceived and misled the complainant, Mrs. Harold Miller, by failing to give information to the complainant as to the condition of the TV set—warranting the set to be worth the expenditure for repairs, when in fact knowing that the cathode-ray tube was in poor condition and needed a booster, and by giving customer bill which did not reflect the true items of material used in repair.

The suspension was to have ended Feb. 28. However, an application for a new license to take effect on that date was denied.

TESA–MISSOURI VOTES

At a recent meeting in Columbia, Mo., of the Television Electronic Service Association of Missouri (TESA–Mo) a seminar on service business operations was conducted by Wayne Lemons and a technical discussion on servicing instrument development by David Doss.

New officers of the group are: Ed

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As much as $15 worth — Everything Brand New and sold to you with a money back guarantee.

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- 100 – ASST. ½ WATT RESISTORS some 5%...$1
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- 35 – ASSORTED 2 WATT RESISTORS........$1
- 50 – ASST. TUBULAR CONDENSERS........$1
- 10 – 6' ELECTRIC LINE CORDS with plugs....$1
- 5 – TV CHEATER CORDS with both plugs......$1
- 4 – 50' SPOOLS HOOK-UP WIRE 4 colors.....$1
- 50 – STRIPS ASST. SPAGHETTI best sizes $1
- 100 – ASST. RUBBER GROMMETS best sizes ..$1
- 100' – TWIN LEAD-IN WIRE 300Ω heavy duty...$1
- 50' – FLAT 4-CONDUCT. WIRE many purposes..$1
- 25'—INSULATED SHIELDED WIRE $1
- 1 – $7 INDOOR TV ANTENNA hi-gain 3 section .$1
- 20 – ASST. TV KNOBS, ESCUTCHEONS, Etc..$1
- 3 – ASST. TOGGLE SWITCHES spst dpdt, etc..$1
- 6 – ASST. SLIDE SWITCHES spst, dpdt, etc....$1
- 4 – BAKELITE KNIFE SWITCHES dpdt $1
- 15 – ASST. ROTARY SWITCHES $15 worth.....$1
- 100' – FINEST NYLON DIAL CORD best size...$1
- 200 – SELF TAPPING SCREWS #8 x ½" $1
- 35 – ASST. RADIO KNOBS screw and push-on ...$1
- 100 – KNOB SPRINGS standard size 3/8" x ½" ..$1
- 100 – ASSORTED KNOB SET-SCREWS........$1
- 25 – ASSORTED CLOCK RADIO KNOBS......$1
- 400 – ASST. H'DWARE screws, nuts, rivets, etc..$1
- 50 – ASST. SOCKETS octal, noval and miniature .$1
- 20 – ASSORTED TUBE SHIELDS best sizes......$1
- 50 – ASST. MICA CONDENSERS some in 5%..$1
- 50 – ASST. CERAMIC CONDENSERS........$1
- 10 – ASST. VOLUME CONTROLS less switch...$1
- 5 – ASST. VOLUME CONTROLS with switch ...$1
- 100 – VOLUME CONTROL HEX NUTS.......$1
- 20 – ASST. PILOT LIGHTS popular types.......$1
- 10 – PILOT LIGHT SKTS. bayonet type, wired...$1
- 50 – ASST. TERMINAL STRIPS 1, 2, 3, 4 lug ...$1
- 10 – ASST. RADIO ELECTRO. CONDENSERS.$1
- 5 – ASST. TV ELECTROLYTIC CONDENSERS.$1
- 15 – ASST. TV COILS sync. peaking, width, etc..$1
- 25 – ASST. MICA TRIMMER CONDENSERS..$1
- 50 – TUBULAR CONDENSERS .001–600v.......$1
- 15 – TUBULAR CONDENSERS .047–600v $1
- 50 – TUBULAR CONDENSERS .01-400v.......$1
- 2 – ELECTROLYTIC COND. 40/40–450V......$1
- 2 – ELECTROLYTIC COND. 10/10/10–450v....$1
- 30 – FP CONDENSER MOUNTING WAFERS..$1
- 3 – ELECTROLYTIC COND. 80–450v.........$1
- 3 – ELECTROLYTIC COND. 30/30–150v $1
- 15 – TUBULAR CONDENSERS .015–1600v.....$1
- 10 – HV TUBULAR CONDENSERS .006–1600v..$1
- 10 – HV TUBULAR CONDENSERS .001–6000v..$1
- 10 – HV TUBULAR CONDENSERS .005–6000v..$1
- 35 – MICA COND. 20–100 mmf & 15–270 mmf.....$1
- 35 – MICA COND. 20–470 mmf & 15–680 mmf.....$1
- 35 – MICA COND. 20–820 mmf & 15–1000 mmf $1
- 35 – CERAMIC COND. 20–5 mmf & 15–10 mmf....$1
- 35 – CERAMIC COND. 20–25 mmf & 15–47 mmf...$1
- 35 – CERAMIC COND. 20–56 mmf & 15–82 mmf ...$1
- 35 – CERAMIC COND. 20–100 mmf & 15–150 mmf ..$1
- 35 – CERAMIC COND. 20–270 mmf & 15–470 mmf ..$1
- 35 – CERAMIC COND. 20–1000 mmf & 15–1500 mmf .$1
- 35 – CERAMIC COND. 20–2000 mmf & 15–5000 mmf .$1
- 50 – 100Ω ½ WATT RESISTORS 5%........$1
- 75 – 470KΩ ½ WATT RESISTORS 10%......$1
- 50 – 15KΩ 1 WATT RESISTORS 10%........$1
- 50 – 470KΩ 1 WATT RESISTORS 10%.......$1
- 25 – 2.2Ω 2 WATT RESISTORS 5%.........$1
- 25 – 100KΩ 2 WATT RESISTORS 10%.......$1
- 10 – ASST. WIREW'ND RES. 5, 10, 20 watts...$1
- 3 – AUDIO OUTPUT TRANS. 50L6 type $1
- 3 – AUDIO OUTPUT TRANS. 6K6 or 6V6 type...$1
- 3 – I.F. COIL TRANSFORMERS 456 kc.........$1
- 3 – I.F. COIL TRANSFORMERS 10.7 mc FM ...$1
- 4 – OVAL LOOP ANTENNAS ass't hi-gain types .$1
- 3 – LOOPSTICK ANT. new ferrite adjustable.....$1
- 12 – RADIO OSCILLATOR COILS 456 kc.......$1
- 3 – ½ MEG VOLUME CONTROLS with switch ..$1
- 5 – 50K VOLUME CONTROLS less switch......$1
- 10 – SURE GRIP ALLIGATOR CLIPS........$1
- 1 – GOLD GRILLE CLOTH 14"x14" or 12"x18"..$1
- 1 – 5" PM SPEAKER alnico #5 magnet.........$1
- 5 – SETS SPEAKER PLUGS wired $1
- 10 – SETS PHONO PLUGS and PIN JACKS..$1
- 2 – $2.50 SAPPHIRE NEEDLES 1000 playings...$1
- 5 – DIODE CRYSTALS 2–IN21 2–IN23 1–IN64 .$1
- 2 – SELENIUM RECTIFIERS 1–65 ma & 1–150 ma $1
- 1 – TV VERT. OUTPUT TRANS. 10 to 1 ratio ...$1
- 5 – TV CRT. SOCKETS with 18" leads.........$1
- 5 – HI-VOLT. ANODE LEADS with 18" leads....$1
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- 1 – SET TV KNOBS standard type incl. decals $1
- 1 – LB SPOOL ROSIN CORE SOLDER 40/60...$1
- 6 – SPIN TIGHT SOCKET SET 3/16" to 7/16"..$1
- 3 – TV ALIGNMENT TOOLS 5", 7", 12"......$1
- $15 – "JACKPOT" TELEVISION PARTS.....$1

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Engle, Crystal City, president; Dennison Houghton, Columbia, northeast vice president; M. C. Crane, St. Joseph, northwest vice president; W. A. Pryer, Mountain Grove, southwest vice president; E. Carroll, Cabool, southeast vice president; Carrol King, Lamar, secretary, and Carl Adcock, Aurora, treasurer. To the board of directors for two years: Robert Matteson, Florissant; Howard J. Freiner, St. Louis; Wayne Lemons, Buffalo, and Arrent Patterson, Springfield.

ATLANTA ELECTION

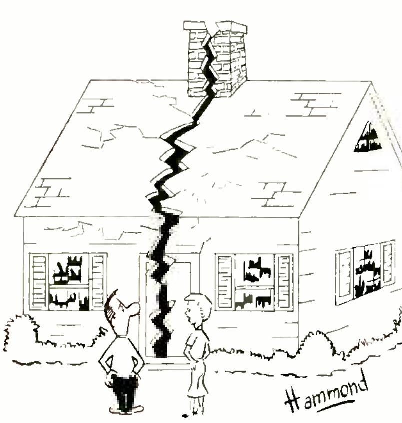
The Radio–Television Service Association of Greater Atlanta Inc., at their annual election meeting in Atlanta, Ga., elected Kermit M. Smith, Decatur Radio & Television Service, as their new president. L. J. Webber, Webbers Radio & Appliance Co., became first vice president; W. H. Steed, Radio Doctor, second vice president; M. Daniels, Fulton Appliance Service, third vice president; Pierce McGee, McGee's Television & Radio Service, secretary, and Joe Mull, Mull Television Co., treasurer.

Elected chairman of the board of directors was Red Tarsa, Riteway Television Co. Board members are Marvin Cochran, Atlanta Electronic Service; W. T. Edwards, Edwards Radio-Television Co., and Arthur Powell, Powell Electronics.

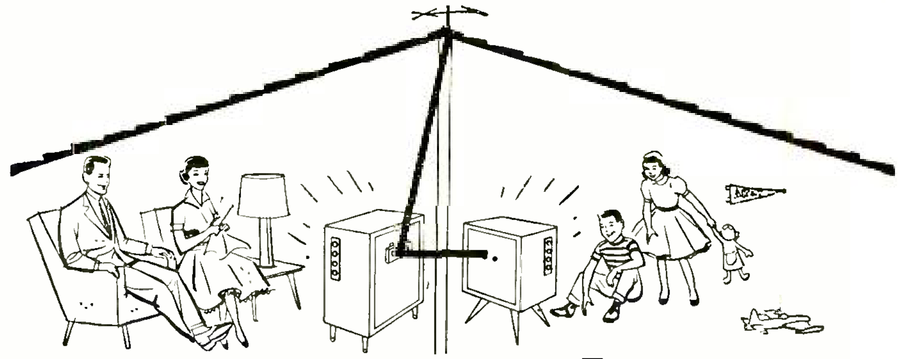
KCTSA MEETING

A program outlining how to avoid taking of "NSF" and "no account" checks was presented by the National Check Protection Service at a regular meeting of the King County Television Service Association Inc. (KCTSA). The meeting was held at the Stewart Hotel in Seattle, Wash.

At the annual meeting held earlier this year, Clayton Faller was elected president for the coming fiscal year. Other members voted to office were: Loyal Gudel, vice president, and Jim Humphrey, secretary-treasurer. Among the new directors are Connie Jenkins, Robert Kelly and Frank Shelton. Hold-over directors are Paul Morvee, Clinton Cox and Carl Pitman. Harold Hart, last year's president, will automatically serve on the board this year. END



"The Hi-Fi has got to go."



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sharper, clearer pictures on 1, 2 or 3 tv sets with 1 antenna

NEW B-T LABS B-23 TWO-SET BOOSTER

From B-T comes the most important step forward in better TV reception for 1958 – a broadband TV amplifier that boosts signal strength on all VHF channels 2-13 and operates 1 or 2 or 3 TV sets with one antenna. No tuning is required.

combines two functions in one

A single B-23 –

- **BOOSTS** signal strength on 1 or 2 or 3 TV sets – up to 6 db gain operating two TV sets from one antenna.
- **COUPLES** 2 or 3 TV sets – using the present antenna. Outperforms non-powered couplers in any reception area by more than 2 to 1.

check these B-23 features:

- Ideal for color – add a color TV set and keep present black-and-white set, use the same antenna – the result, sharper, clearer pictures on both sets.
- Low noise figure – designed to work with new VHF sets.
- Reduces interference.
- Easily installed at antenna terminals of set. Can be mounted out of sight at the rear of the receiver.
- Automatically amplifies channels 2-13.
- Ideal small TV system (motels, multiple dwellings, TV showrooms).

FOR OPERATING 3 TO 8 TV SETS, USE THE B-T LABS DA8-B – MORE THAN 10 DB GAIN ON ALL VHF CHANNELS.

The DA8-B Distribution Amplifier is a broadband, all-channel unit that requires no tuning, impedance matching devices, pre-amps or other special fittings. Ideal for all small TV systems including garden apartments, motels, TV showrooms serving more than 3 sets. Approved for color, only $94.50.

The B-23, the DA8-B, and a host of other B-T quality engineered products to improve television reception, are available at electronic parts distributors.

For further information, use coupon.

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HIGH-POWER **OUTPUT PENTODE**

High-fidelity authorities are not in agreement as to which is "best" among the handful of genuinely great power amplifier designs available today. But one thing they know for sure—at least 4 out of 5 of the contenders have 6CA7/EL34's in the output stage. No other comparable tube combines to the same degree the 6CA7's exceptional linearity, high power dissipation and low drive-voltage requirements. It is a true pentode design, with a separate suppressor grid that controls the space charge, resulting in greater linearity on reactive speaker loads than is possible with competitive beam-power tetrodes. A single pair of 6CA7's in push-pull has been successfully used in power amplifiers delivering up to 100 watts undistorted output.

OTHER **Amperex TUBES** FOR HIGH-FIDELITY AUDIO APPLICATIONS:

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ECC81/12AT7 Low-noise medium-μ dual triode
ECC82/12AU7 low-noise low-μ dual triode
ECC83/12AX7 Low-noise high-μ dual triode
GZ34 Cathode-type rectifier; 250 ma.
EZ80/6V4 9-pin rectifier; cathode; 90 ma.
EZ81/6CA4 9-pin rectifier; cathode; 150 ma.

At All Leading Electronic Parts Distributors

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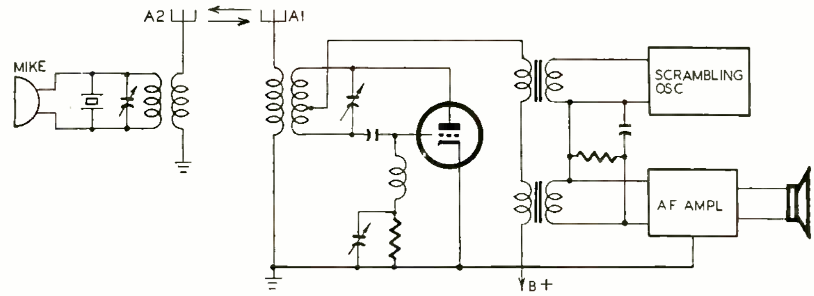
230 Duffy Ave., Hicksville, Long Island, N.Y.

Patents

PASSIVE RESPONDER

Patent No. 2,812,428

Karl Rath, New York, N. Y. (Assigned to Radio Patents Co., New York, N. Y.)



A conventional radio transmitter needs power to operate it. However a remote station can be set up to pick up rf from another station, modulate it, then retransmit it, so no local power is required. The master station is shown at the right of the diagram. It is a simple superregenerator, self-quenched at about 50 kc. The carrier may be 50 mc which is radiated from A1 to the remote antenna A2. The output of a superregenerator circuit is composed of pulses of rf.

The receiver tank is tuned to the same carrier and is shunted by a resonant quartz crystal. Like any vibrating device, the crystal absorbs power one instant, returns it the next. Thus, after a short delay, the crystal generates rf of the same frequency as that received, and power is radiated from A2. The microphone (when spoken into) modulates the rf. Due to time delay by the crystal, the pulses received at A1 arrive between intervals of superregenerator pulses.

When a modulated signal is picked up by a superregenerator, the receiver oscillations are similarly modulated. For that reason it is possible for an unauthorized listener to tune to A1 and receive the messages from A2. To avoid this possibility, a local scrambling oscillator is added as shown. The same scrambling process is also applied to the incoming audio signal to cancel out the interference. Therefore the reproduced signal is free of interference, yet secrecy is preserved so far as other stations are concerned.

AUTOMATIC TELEPHONE DIALING

Patent No. 2,813,931

Lee de Forest, Los Angeles, Calif.

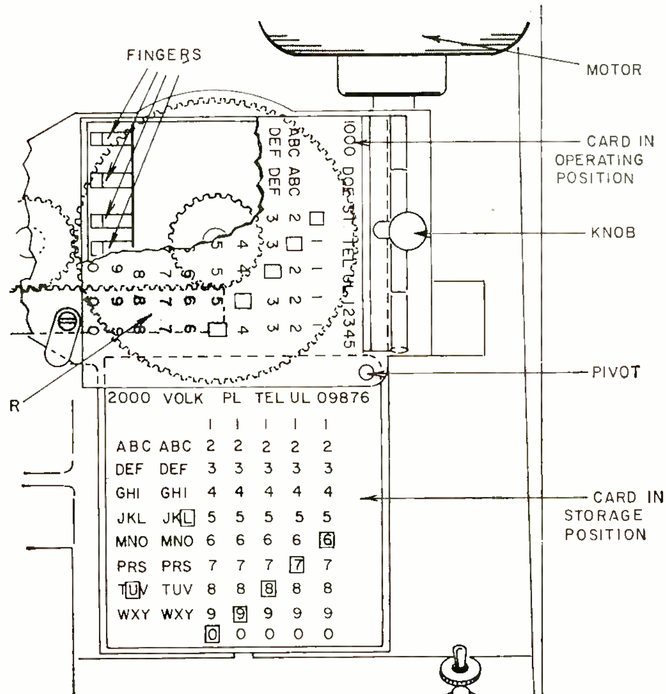
This invention eliminates dialing errors and expedites dialing calls. It is attached to one side of a dial telephone and has a hinged drive mechanism that drops down on the dial. The mechanism swings up so the dial can be operated manually. When the arm is lowered, a large gear locks on the dial so that both turn for automatic dialing.

A punched card is needed for each phone number. To make a call, the desired card is moved (on its pivot) from the storage to the operating position. See diagram. A metal plate over the card holds it in place.

A switch starts the motor. A set of gears drives the rack R together with a crossbar and a set of seven metal fingers. The fingers start to move from the top of the card, and each can complete a circuit upon contacting the metal plate (through punch holes in the card). Each finger is synchronized by a rotary switch so it is in the circuit in sequence.

As R moves downward, the first finger moves beneath the card until it contacts the metal plate through the U perforation in the card (which is punched for UL 1-2345). At this time the dial has reached letter U also. The contact releases the gear mechanism through solenoid action. R flies back to its starting position, and the dial returns to its resting place. Then R advances again, this time with the second finger connected into the circuit. When this metal part reaches the perforation in letter L, contact is again made and the gear train returns to its starting position. Of course, L has now been dialed. In this way the five digits are dialed in turn.

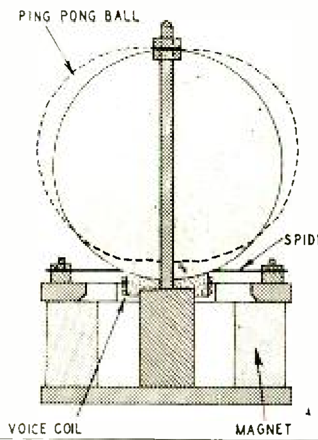
Interested readers are referred to the patent specification for complete details. END



radio-electronic Circuits

SPHERICAL TWEETER

The ideal pulsating sphere of all acoustics textbooks is cleverly approximated by K. H. Becker in an arrangement which appeared in *Funkschau*, *11-56*.



The high-frequency directivity of the ordinary cone loudspeaker is very marked, and the usual remedies are diffusing contraptions or multiple-speaker arrangements.

The loudspeaker represented in the diagram replaces the cone by a spherical, ellipsoidal or ovoidal body. One pole or end is clamped and the other pole glued to the moving coil.

To improve its elasticity, it is recommended that slots be cut along the meridians between the two poles.

The displacement of the moving coil alternately expands and contracts the pulsating sphere. The sound is radiated toward the sides and upward.

The best practical results have been obtained using a ping-pong ball, with two diametrically opposed axial slots. The frequency range then extends from 2,000 to 15,000 cycles.—*A. V. J. Martin*

30–50-MC BOOSTER

Some of the less-expensive FM receivers for monitoring fire, police and similar radio services in the 30–50-mc band do not have enough gain for good quieting when receiving weak mobile stations. This low-noise cascode booster will improve these receivers.

L2 and L3 are Cambridge Thermionic Corp. (CTC) type LS3 30-mc inductors. L1 and L4 are antenna and output coupling coils. Each should be adjusted for maximum signal. Use hookup wire and start with about six turns around

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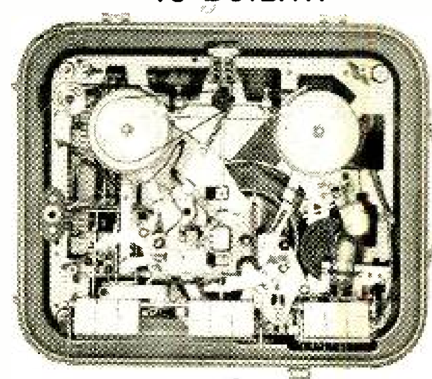

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Actually less than .1% *distortion* under all normal operating conditions. *Response* ±.5 db 6 cps to over 60 kc. Distortion and response unaffected by settings of volume control. Superlative square wave performance, and complete damping on any pulse or transient test.

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All critical parts supplied factory-mounted on XXXP printed circuit board. Eyeleted construction prevents damage to printed wiring. This type of construction cuts wiring time by 50% and eliminates errors of assembly. Open simplified layout offers complete accessibility to all parts.

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Integral dc heater supply plus low noise components and circuitry bring noise to less than 3 microvolt equivalent noise input on RIAA phono position. This is better than 70 db below level of 10 millivolt magnetic cartridge.

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1% components in equilization circuits to insure accurate compensation of recording characteristics. Long life electrolytic capacitors and other premium grade components for long trouble-free service.

★ High flexibility

Six inputs with option of extra phono, tape head, or mike input. Four AC outlets. Controls include tape AB monitor switch, loudness with disabling switch, full range feedback tone controls. Takes power from Dynakit, Heathkit, or any amplifier with octal power socket.

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Choice of bone white or charcoal brown decorator colors to blend with any decor. Finished in indestructible vinyl coating with solid brass escutcheon.

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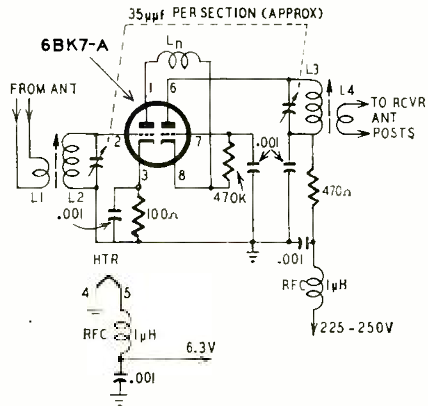
the bottom ends of L2 and L3. Neutralizing coil L" should be approximately 40 turns of No. 24 enameled wire wound on a ¼-inch form. Vary the number of turns and the spacing for minimum noise.

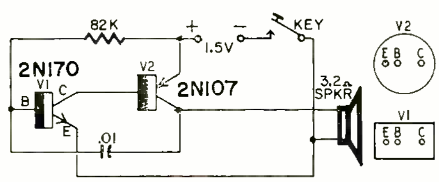
The tuned circuits can be aligned



so they track reasonably well by carefully adjusting the slugs in L2 and L3. Tracking can be adjusted more precisely by connecting a small trimmer of around 5 μμf across each section of the tuning capacitor and varying their settings along with those of the tuning slugs for optimum performance.

TRANSISTOR CODE OSCILLATOR

Two transistors, a resistor, a capacitor, a loudspeaker, a telegraph key and a 1.5-volt penlight cell are all that are required for this simple and reliable code-practice oscillator. Volume is sufficient for classroom use, especially with an efficient loudspeaker. A direct-coupled positive-feedback circuit is used



with one n-p-n transistor and one p-n-p transistor.

Don't reverse the transistors or the voltage source polarity. The oscillator frequency can be lowered by using more capacitance, more resistance, or both. With the circuit constants given, the frequency is between 600 and 800 cycles. If one of the widely advertised 89c surplus telegraph keys and 99c manufacturer's surplus speakers are used, total cost will be less than $5. Keying is clean and crisp if key contacts are not dirty. Total battery drain is less than 4 ma, low enough for obtaining many ham tickets before the first penlight cell is exhausted!—*Harold Balyoz, W6YBP.* END

HEARING RANGE

By Jeanne DeGood

Since Hi-Fi gives me any tone
That any human hears,
What sounds are there I might have known
If they'd improved my ears?

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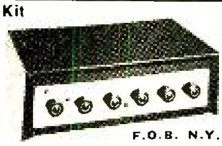

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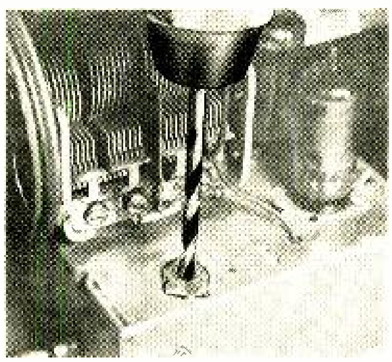
SHOP HINTS

When more sensitive means aren't available, use a voltage regulator tube as a handy rf indicator. Tubes like the OB3/VR90 or OD3/VR150 serve well. For low power, touch terminal 2 or 5 to the rf source and the gas inside will glow. For higher power, hold the glass envelope in the rf field and the gas inside the tube will glow. The more rf, the brighter the glow in the tube, so that a resonance point is indicated by maximum glow—*S. Clark*

SOLDER AIDS DRILLING

To drill a hole in a metal radio or TV chassis, you must usually center-punch a pilot hole to give the drill an accurate start. The usually deforms the metal around the hole and gives the chassis and its many vibration-sensitive components a severe jolt.



To prevent this, form a thin layer or pool of solder over the spot where the hole will be drilled. The drill won't have any trouble eating into the soft solder and it will enter the chassis surface accurately without a center-punched pilot hole.—*J. C. Alexander*

DRINKING-STRAW SPAGHETTI

It recently occurred to me that wire insulating spaghetti is commonly sold for another purpose at the grocer and five-and-dime stores. Not only is it available at these stores, but it comes in a variety of colors and sizes! I'm referring, of course, to plastic drinking straws. They make ideal wire insulating spaghetti. I often pick up a pack of them right along with my weekly groceries. They're inexpensive too.—*John A. Comstock*

FUSE-CLIP BURNISHER

I clean and brighten the metal clips of tubular fuse holders with a 1½-inch wide strip of fine abrasive cloth wrapped around the ¼-inch shank of a screwdriver. The abrasive cloth is

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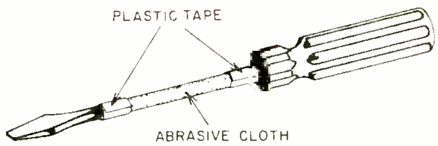


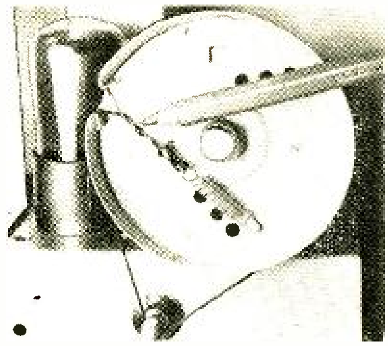
held in place with plastic tape. The fuse-size shank is an almost perfect fit and just a few turns of the handle makes fast work of burnishing the clip's inner surfaces. Since I came across a few really bad cases of high contact resistance due to slip corrosion, I've made it a habit to clean fuse-clip contacts every time I replace a tubular fuse.—*Scott Mack*

BATTERY TO SPEAKER CONNECTIONS

When discarding a dead portable battery, cut out and save any snap-on battery connectors. Many of these can be matched to each other. Next time you want to put connections onto a PM speaker just solder the snap-on clips to the speaker leads.—*A. Von Zook*

TIGHTENING DIAL CORDS

After considerable use, dial cables have a tendency to stretch and to slip on the tuning shafts. There are several ways to remedy slipping dial cables. You can apply nonslip compound to the cable where it goes around the shaft or, if possible, move the cable spring to a place on the drum where it puts more pull on the cable or shorten the cable or replace the old cable with a new one. However, I feel that my method is one of the simplest and most effective.



If the cable is in good condition, but simply slips on the tuning shaft, you can tighten it easily. Simply remove the bottom end of the cable spring from the lug of the drum, give the cable a few twists at the place pointed out in the photo, and hook the spring back on the drum lug again. The twists shorten the cable so the spring puts more tension on it. Experiment with the number of twists needed.—*Art Trauffer*

KEEPING THE IRON CLEAN

I keep the tip of my soldering iron clean and free of scale by occasionally holding it against a revolving wire brush. The stiff wire bristles of the brush remove all traces of scale and solder. Then the iron can be readily tinned.—*John A. Comstock* END

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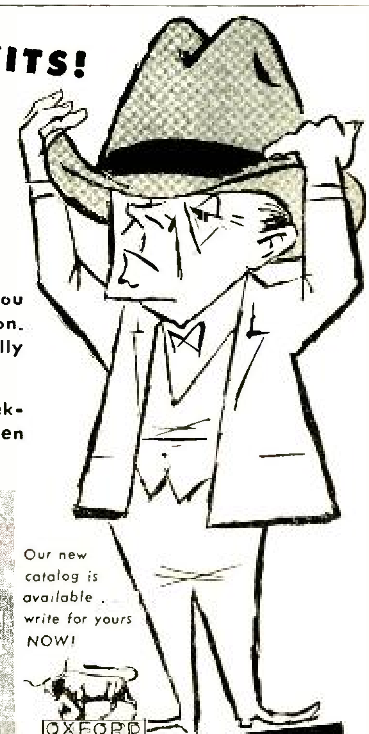

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Technotes

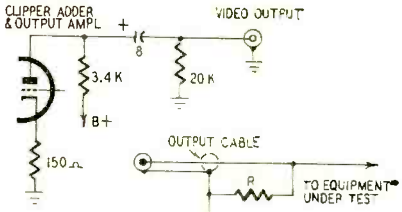
WATERLOGGED AUTO ANTENNA

Sometimes the insulation at the bottom of an auto antenna wears or breaks, allowing water to leak down the antenna, grounding it out. A fast, temporary remedy is to slip a boot from the end of an auto-brake master cylinder over the antenna and down to the cowl, forming an effective seal.—*E. Mayover*

DEFECTIVE BAR GENERATOR

This complaint concerned a color bar generator. When the generator was used to drive known good color TV receivers, only gray bars were produced, with no visible color.

It was a Telechrome generator, using the output circuit shown in the diagram. We started checking waveforms and found a normal signal at the grid of the tube. Evidently, high-frequency attenuation was taking place in the plate circuit.

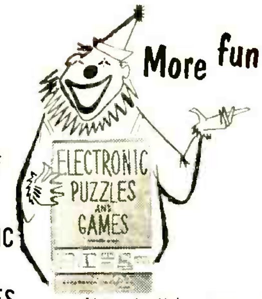


It was apparent from the circuit diagram that the plate load (3,400 ohms) was much too high to obtain high-frequency output. However, the output cable is a branch of the ac plate load. We checked the cable and found no terminating resistor (R)—it had evidently been removed by someone who thought that it didn't make any difference or something. We connected a 75-ohm resistor across the cable's terminals and presto—we were back in the color business.—*Robert G. Middleton*

MOTOROLA TS-539

Symptom: No agc, picture comes in momentarily after channel selection, then blanks out.

Measure the agc voltage at the tuner's agc terminal with no signal present. There should be 1 volt at this point. If no agc is present and the 6AU6 agc tube checks good, try replacing the 6DQ6 horizontal output. If this tube is shorted (and this has happened several times without noticeably affecting brightness or blowing the fuse), no agc will be developed. On one particular receiver, the symptoms



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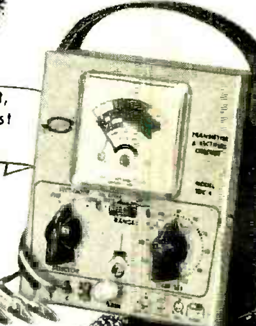

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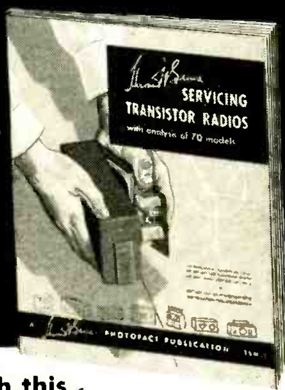

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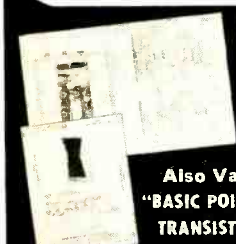

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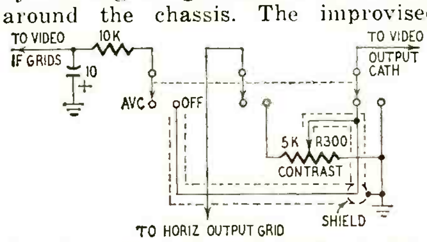
did not point to a defective 6DQ6 because brightness and width were perfectly normal.—*John B. Ledbetter*

PHILCO 49-1002

Complaint was a wormy (grainy) picture. A clue to the trouble was found by moving a grounded metal plate around the chassis. The improvised



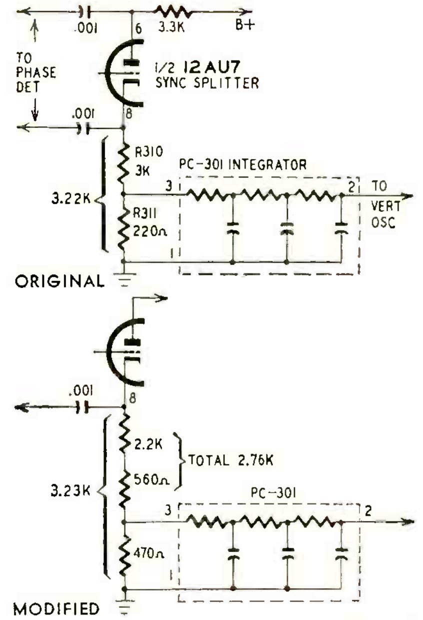
shielding wand showed feedback from the wire connecting the center arm of the contrast control (R300, 5,000 ohms) to the manual avc switch.

This video feedback was eliminated by running the lead in a shielded cable whose outer braid was grounded at both ends.—*A. R. Clawson*

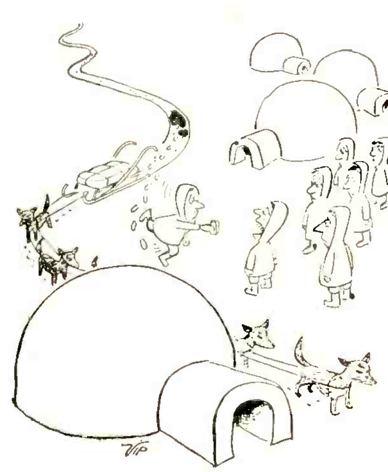
MAGNAVOX CTA440AA

The set was suffering from critical vertical sync. To solve the problem, the sync pulse delivered to the PC integrator was increased by making the modification shown in the diagram.

The vertical takeoff was across the 220-ohm portion of the cathode resistance (R311). This was changed to 470 ohms. The horizontal feed from the cathode of the phase splitter must be



about equal to that from its plate circuit. To make the cathode resistance nearly the same, R310 (3,000 ohms) was replaced with two resistors, 2,200 and 560 ohms. Total cathode resistance of the 12AU7 is now 3,230 ohms in place of the original 3,220 ohms. Locking and interlace are better.—*Eugene Rollins.* END



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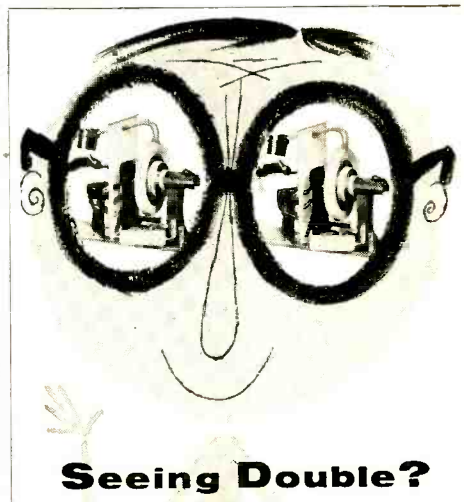

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Business and People

J. R. Whiteside, executive vice president of Simpson Electric Co., Chicago, was named president.

George S. Bond, joined Howard W. Sams & Co., Indianapolis, Ind., as assistant to the chairman of the board, Howard W. Sams. Bond comes from P. R. Mallory where he was advertising and sales promotion manager.

Helen Staniland Quam of Quam Nichols Co., was elected president of the Association of Electronic Parts & Equipment Manufacturers Inc., the

first woman to head a major electronics industry trade group. **Gail S. Carter** (left) Merit Coil & Transformer Corp., was elected first vice president, and **Robert E. Svoboda**, Amphenol Electronics Corp., was elected second vice president. **Kenneth Hathaway**, Ward Leonard, was re-elected treasurer, and **Kenneth C. Prince**, executive secretary.

Victor Mucher, president of Clarostat Manufacturing Co., Dover, N. H., was honored on his 49th birthday by the Dover Rotary Club of which he is president. Friends, relatives and business associates surprised him in a takeoff of the TV program "This Is Your Life."

Photo shows Vic Mucher, seated, with his wife (right) and two sisters. Standing (left to right) are his two brothers, William and George; Austin C. Lescarboura, head of the agency which has handled Clarostat advertising for over 32 years, and Charles Golenpaul, vice president of Aerovox, an old friend.

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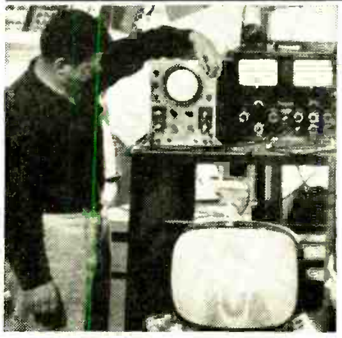

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Joseph R. Owen was appointed manager of advertising and sales promotion for the General Electric Specialty Electronic Components Dept., Auburn, N. Y. He will be responsible for promotion activities on the department's high-fidelity audio components and specialized electronic materials and devices. He had been in charge of sales promotion in the G-E Television Receiver Dept.

Bob Mueller (left) and **Leon Ungar** (right), partners in Ungar-Mueller Sales Co., Southern California representatives for General Cement Manufacturing Co., Rockford, Ill., were presented with the Salesman of the Year Award by W. H. Dean (center), Western Sales Manager for General Cement, for outstanding achievement in total volume and largest percentage increase in distributor sales in the Western division.

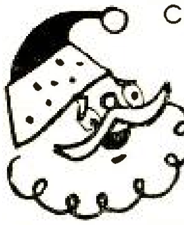
Business

Raytheon Manufacturing Co. Receiving Tube and Semiconductor Operations, Newton, Mass., was honored with the NATESA Friends of Service Management Award. In the photo, Frank Moch, executive director of NATESA, is shown presenting the award to Norman B. Krim, vice president and general manager of Raytheon's receiving tube and semiconductor operations, while (left to right) F. B. Simmons, E. I. Montague, F. E. Anderson and J. A. Hickey, Raytheon executives look on.

Cornell-Dubilier, South Plainfield, N. J., is promoting the sale of its Mylar tubular capacitors by merchandising them in a clear plastic dispenser which holds 80 of the most popular units.

In the April issue this column reported that **Lewis J. Shioleno** had been named vice president and general manager of Erie Resistor Corp., Erie, Pa. Actually Mr. Shioleno was promoted to general manager of the Electronics Division. **Byron B. Minnium** is vice president and general manager of Erie Resistor Corp.

CHRISTMAS IN JUNE!



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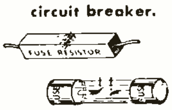

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Rek-O-Kut Co., Corona, N. Y., is offering a trip for two to the Brussels World's Fair and to Paris as the grand prize in a new dealer–consumer contest. In the photo, Cliff Shearer, marketing director of Rek-O-Kut, is being greeted

by Al Gross of Sabena Belgium Airlines and by Avery Yudin, Rek-O-Kut sales manager, on returning from Brussels where he arranged the trip.

Clark Gibb (right), president of The Paul Bunyan Chapter is welcomed back to The Representatives by Jules Bress-

ler, national president. The application of the Minnesota group was approved by the board of governors.

General Cement Manufacturing Co. purchased Microphone Division of Elgin National Watch Co. and will move the operation to Rockford, Ill., where it will function as American Microphone Manufacturing Co., a division of GC-

Textron Inc. The present sales organization remains intact. Photo shows Stanley B. Valiulis (seated right), president of General Cement, signing the contract as Elgin and General Cement executives look on. END

CORRECTIONS

In our *New Records* on page 129 of our February, 1958 issue, the line "Vox L-3 (16⅔ rpm)" was misplaced; it should have appeared between "Borodin: Polovetsian Dances" and "Round the World, Round the Clock" and not at the top of the listing.

In the April issue (page 42) we announced a number of articles planned as features in the May Special Transistor Issue. Unfortunately, last-minute publishing difficulties and technical bugs prevented publication of all the articles. We deeply regret this and assure you these interesting articles on transistors will appear in early issues.

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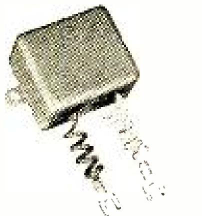

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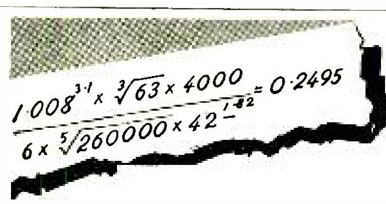

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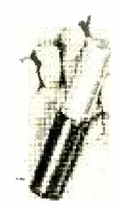

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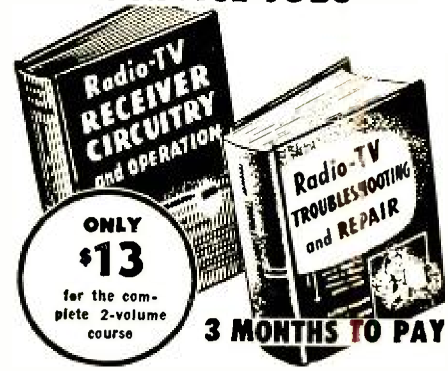

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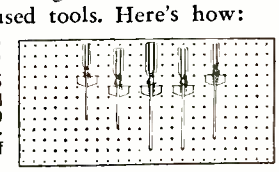

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APPLICATION NOTES for using silicon junction rectifiers to protect sensitive current devices are presented in Vol. 1, No. 1 of *Semi-conductor Application Notes*. This issue illustrates how the nonlinear characteristics of silicon diodes, in both the forward and Zener operating regions, make them ideally suited to protecting ac and dc measuring instruments.—**Hoffman Electronics Corp.**, Semiconductor Div., 930 Pitner Ave., Evanston, Ill.

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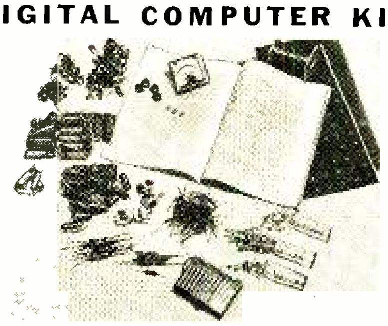

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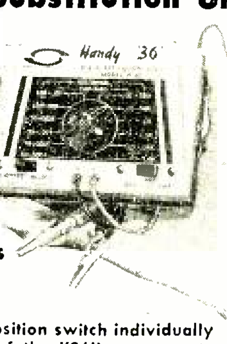

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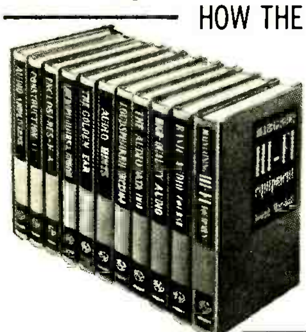

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Books

ALL ABOUT ELECTRICITY, by Ira M. Freeman. Random House, Inc., 457 Madison Ave., New York 22, N.Y. 7 x 9¼ inches, 141 pages. $1.95.

This is one of an "all-about" series that includes birds, flowers, stars, etc. It is intended for "readers of 10 to 15" but perhaps not for youngsters who already happen to experiment with transistors, build portable radios or operate ham stations.

With helpful illustrations, the book is simple, effective and as clear as possible for such a topic. Principles of the telephone, battery, electromagnetism, power transmission and radio are skillfully treated in a way to attract the interest of future scientists. Color TV appears briefly, and transistors are also mentioned.

For the benefit of young minds, the author has dramatized the basic discoveries of Franklin, Galvani, Oersted, Bell, Marconi and others. These stories introduce the reader to the principles and applications that follow.—*IQ*

SYLVANIA SERVICE INFORMATION, Vol. 2. Sylvania Electric Products Inc., Radio & Television Div., Service Dept., Batavia, N.Y. 11 x 17 inches, 138 pages. $3.50.

A comprehensive manual of service information, schematic diagrams, production changes, test and alignment points and parts lists for Sylvania radio, TV and audio equipment produced between May, 1954, and December, 1957.—*RFS*

UNDERSTANDING ELECTRONICS, by John Lewellen. Thomas Y. Crowell Co., 432 4th Ave., New York, N. Y. 5½ x 8¼ inches. 213 pages. $2.75.

This most recent of a series of books intended to give the nontechnical beginner an insight into some of the involved mechanics of the modern world presents a fascinating picture of electronics. Starting off with "Can you imagine anything changing its direction 500,000 times a second?" the author takes the reader through a tour of basic electricity, magnetic fields, how electrons behave, how the parts of radio work and even describes transistors. For the layman who wants to know what makes things tick.—*LS*

MOST-OFTEN-NEEDED 1958 TELEVISION SERVICING INFORMATION. Compiled by M. N. Beitman. Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. 8½ x 10½ inches, 192 pages. Price $3.

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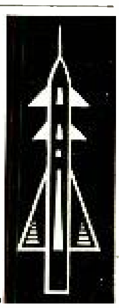

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According to these authors, the purpose of this book is to teach. This it should do very well, for there is a good balance between basic theory and practical circuit design. The text is the result of a successful technical course, and it is written at the level of the senior student or graduate engineer.

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COMMERCIAL RADIO OPERATOR'S LICENSE GUIDE, by Martin Schwartz. American Electronics Co., 1203-05 Bryant Ave., New York 59, N.Y. 6 x 9 inches. Elements 1 and 2, 48 pages, 75c. Element 3, 122 pages, $1.75.

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RADIO AMATEUR'S HANDBOOK. American Radio Relay League, Inc., W. Hartford, Conn. 35th Edition, 6½ x 9½ inches, 746 pages. $3.50 in US, $4 in possessions, $4.50 elsewhere.

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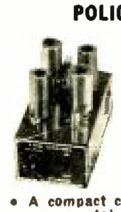

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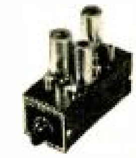

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1H5GT	.85
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1L6	1.05
1LA4	1.00
1LA5	1.00
1LB4	1.25
1LC5	1.10
1LC6	1.10
1LD5	1.10
1LE3	1.10
1LG5	1.10
1LH4	1.10
1LN5	1.10
1N5GT	1.05
1Q5GT	1.10
1R4	1.00
1R5	.85
1S4	.80
1S5	.80
1T4	.80
1T5GT	.90
1U4	.80
1U5	.75
1V	1.00
1V2	.65
1X2B	1.10
2A3	2.00
2AF4A	1.35
2BN4	.90
2D21	1.10
2N2	.55
3A3	1.10
3A4	.75
3A5	.75
3AL5	.65
3AU6	.75
3AV6	.60
3BE6	.85
3BC5	.85
3BN6	1.00
3BU8	.95
3BY6	.85
3BZ6	.85
3CB6	.85
3CF6	.90
3CS6	.85
3DT6	.80
3LF4	1.25
3Q4	.75
3Q5GT	1.15
3S4	.85
3V4	.85
4BC8	1.40
4BQ7A	1.40
4BS8	1.35
4BU8	1.20
4BZ7	1.40
5A6	2.10
5AM8	1.15
5AN8	1.25
5AQ5	.75
5AS8	1.20
5AT8	1.15
5AU4	1.30
5AV8	1.35
5AW4	1.25
5AZ4	.85
5BK7	1.20
5BR8	1.20

5BQ7	[illegible]
5CG8	[illegible]
5J6	[illegible]
5R4GY	[illegible]
5T8	[illegible]
5U4G	.80
5U4GB	.80
5U8	1.15
5V4G	[illegible]
5V6GT	.85
5W4GT	[illegible]
5X4G	.80
5X8	1.15
5Y3GT	.60
5Y4G	.80
5Z3	1.00
5Z4	[illegible]
6A7	[illegible]
6A8M	[illegible]
6A8GT	[illegible]
6AB4	.75
6AB5	[illegible]
6AB7	[illegible]
6AC5GT	1.35
6AC7	[illegible]
[illegible]	[illegible]
6AF4	1.45
6AF6G	1.20
6AG5	[illegible]
6AG7	[illegible]
6AH4GT	1.05
6AH6	1.40
6AK4	[illegible]
6AJ5	1.85
6AK5	[illegible]
6AK6	.95
6AL5	.65
6AL7GT	1.80
6AM4	1.90
6AM8	1.15
6AN4	1.65
6AN5	3.70
6AN8	[illegible]
6AQ5	.75
6AQ6	.70
6AQ7GT	1.15
6AR5	.75
6AR6	2.35
6AS5	.85
6AS6	1.00
6AS7G	3.00
6AS8	1.15
6AT6	.70
6AT8	1.15
6AU4GT	1.15
6AU5GT	1.50
6AU6	.75
6AU7	1.00
6AU8	1.20
6AV5GT	1.25
6AV6	.60
6AW8	1.25
6AX4GT	.90
6AX5GT	1.05
6AZ8	1.45
6B4G	1.85
6BA6	.70
6BA7	1.25
6BC4	1.80
6BC5	.80
6BC7	1.15
6BC8	1.40
6BD5	1.25
6BD6	.70
6BE6	.75
6BF5	.80
6BF6	.65
6BG6G	2.25
6BH6	.95

[illegible]	[illegible]
6BK7A	[illegible]
6BL7GT	[illegible]
6BN4	.85
6BN6	1.00
6BQ7A	[illegible]
6BR8	[illegible]
6BS8	1.45
[illegible]	[illegible]
6CB5	[illegible]
6CB6	.80
6CH8	[illegible]
6CL6	[illegible]
6CM6	[illegible]
6CM7	.95
6CN7	[illegible]
6CR6	.85
6CS6	[illegible]
6CS7	.95
6CU5	.90
6CU6	1.50
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6DC6	[illegible]
[illegible]	.85
6DT6	.85
6DQ6	1.55
6E5	1.00
6F5	1.10
6F6M	1.35
6F6G	1.00
6H6	.75
6J4	2.00
6J5	.85
6J6	.75
6J7	1.20
6K6GT	.80
6K7	1.00
6K8	1.40
6L6G	1.50
6L6GA	1.50
6L6M	2.00
6L7	1.40
6N7	1.25
6Q7	1.10
6S4	.75
6S8GT	1.00
6SA7GT	1.05
6SC7	1.05
6SF5	.85
6SF7	1.20
6SG7	1.10
6SH7	.85
6SJ7M	.85
6SK7GT	.90
6SL7GT	1.10
6SN7GT	.90
6SQ7GT	.85
6SR7	.90
6SS7	1.05
6ST7	1.10
6T4	1.30
6T8	1.15
6U5	1.00
6U8	1.15
6V3A	1.45
6V6GT	.75

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7A4	[illegible]
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7B4	.75
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7K7	[illegible]
7N7	.85
7Q7	1.20
7R7	1.40
7V7	1.30
7W7	1.30
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7Y4	.80
7Z4	.80
8AW8A	[illegible]
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12A4	.90
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12AL5	.65
12AQ5	[illegible]
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12AT7	[illegible]
12AU6	.75
12AU7	.85
12AV6	.60
12AV7	1.10
12AW6	1.05
12AX4GT	.95
12AX7	.85
12AY7	1.70
12AZ7	.95
12B4A	.90
12BA6	.70
12BA7	1.25
12BD6	.70
12BE6	.75
12BF6	.75
12BH7A	1.05
12BK5	1.20
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12BQ6GTB	1.55
12BR7	.85
12BV7	1.00
12BY7A	1.05
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12C5	.80
12CA5	.85
12CU6	[illegible]
12DQ6	[illegible]
12J5GT	.85
12K7GT	1.00
12K8	1.50
12L6GT	.85
12Q7GT	1.00
12SA7GT	1.05
12SC7	1.00

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12SQ7GT	[illegible]
12SR7	[illegible]
12X4	[illegible]
14A4	1.25
14A7	1.00
14AF7	1.05
14B6	.90
[illegible]	[illegible]
14R7	1.30
[illegible]	[illegible]
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25AX4GT	[illegible]
25BK5	[illegible]
25BQ6GT	1.00
25CD6GA	1.90
25CU6	1.40
25L6GT	.80
25W4GT	.95
25Z5	1.00
25Z6GT	1.00
35A5	1.00
35B5	.90
35C5	.75
35L6GT	.85
35W4	.50
35Y4	.80
35Z3	.80
35Z4	.65
35Z5	.65
41	.90
42	.90
43	1.00
50A5	1.10
50B5	.90
50C5	.75
50L6GT	.85
50X6GT	.90
50Y6GT	.75
50Y7GT	.75
70L7GT	2.70
80	.85
81	1.75
83	1.35
83V	1.25
117L7GT	2.70
117N7GT	2.00
117P7GT	2.00
117Z3	.85
117Z4GT	1.20
117Z6GT	1.40
5642	1.05

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More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. Its unique flexibility permits the reception of binaural broadcasting (simultaneous transmission on both FM and AM), the independent operation of both the FM and AM sections at the same time, and the ordinary reception of either FM or AM. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate flywheel tuning and separate volume control for proper balancing when used for binoural programs. Simplified accurate knife-edge tuning is provided by magic eye which operates independently on FM and AM. Automatic frequency control "locks in" FM signal permanently. Aside from its unique flexibility, this is, above all else, a quality high-fidelity tuner incorporating features found exclusively in the highest priced tuners.

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The 5 controls of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dark maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal cover, a step-by-step instruction manual, schematic and pictorial diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 18 lbs.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-300 Audio Control Center Kit and KT-400 70-watt Basic Amplifier Kit and the "Triumvirate" of these 3 units form the heart of a top quality stereo hi-fi system.

KT-500..Net **74.50**

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ONLY LAFAYETTE'S HYSTERESIS—SYNCHRONOUS MOTOR, in its price class, is made to extremely fine tolerances (on the order of .00001 inches)! Only Lafayette's motor has 16 cores; a high permeability rotor magnet, ball thrust bearings, oilite sleeve bearings plus felt oil reservoir, cooling fins as an integral part of the rotor and a hollow rotor core for maximum efficiency and minimum heat. Only Lafayette's motor can be oiled from above, without disassembly, through a unique oil feed system. Only Lafayette's motor has a self-aligning armature.

Here's THE turntable—the last word in professional high-fidelity performance! A fine precision instrument in every sense. Just look at some of these ***OUTSTANDING FEATURES:-*** **WOW AND FLUTTER:** Less than 0.2% • **TURNTABLE:** Heavy, diecast aluminum. Lathe-turned for perfect balance and concentricity. 12" diameter—weighs approx. 4 lbs. and provides amazingly constant speed; the extra-heavy rim acts just like a flywheel to prevent speed variations • **TRUE-HYSTERESIS-SYNCHRONOUS MOTOR:** For smooth, low-noise, wow- and flutter-free operation • **RUMBLE: AND NOISE:** 50db below average recorded level • **INTEGRATED SPEED CONTROL:** For all 3 speeds—78, 45 and 33⅓ rpm • **2 OVERSIZE, HEAVY DUTY IDLERS:** Precision-ground; provide positive constant-speed rim drive • **SINGLE BALL THRUST BEARING:** Turntable rides smoothly over ball bearing floating on thin film of oil • **FREE FLOATING, SHOCK-MOUNTED MOTOR** • **RUBBER CUSHION SHOCKMOUNTS** • **AUTOMATIC IDLER DISENGAGEMENT** • **CORK AND RUBBER MAT** • **STAINLESS STEEL PRECISION SPINDLE** • **POWER REQUIREMENTS:** For 105-130 volts, 60 cps AC; draws 16 V.A. • **ACCESSORIES SUPPLIED:** 45 RPM adapter, Strobe disc • **SIZE:** 2⅛" above and 4" below motor board; 14¾" deep x 12¼" wide • **SHIPPING WEIGHT:** 16 lbs.

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MODEL
PK-225

VISCOUS DAMPED TRANSCRIPTION TONE ARMS

PK-90— **11.95**
VISCOUS DAMPED ARM

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SPECIAL MONEY-SAVER COMBINATION
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- HIGHLY STYLED PLASTIC CASE
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- ECONOMICAL—USES ONLY ONE BATTERY

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Including Earphone, Battery and Carrying Case

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PA-13— Power Megaphone, Less batteries .... Net **29.50**

BATTERIES FOR ABOVE— Burgess No. 2 or RCA
VS036—8 Required .... Net each **.13**

Reg. Value ~~69.50~~
ONLY **29.50**

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Only 6½ lbs.
THROWS VOICE
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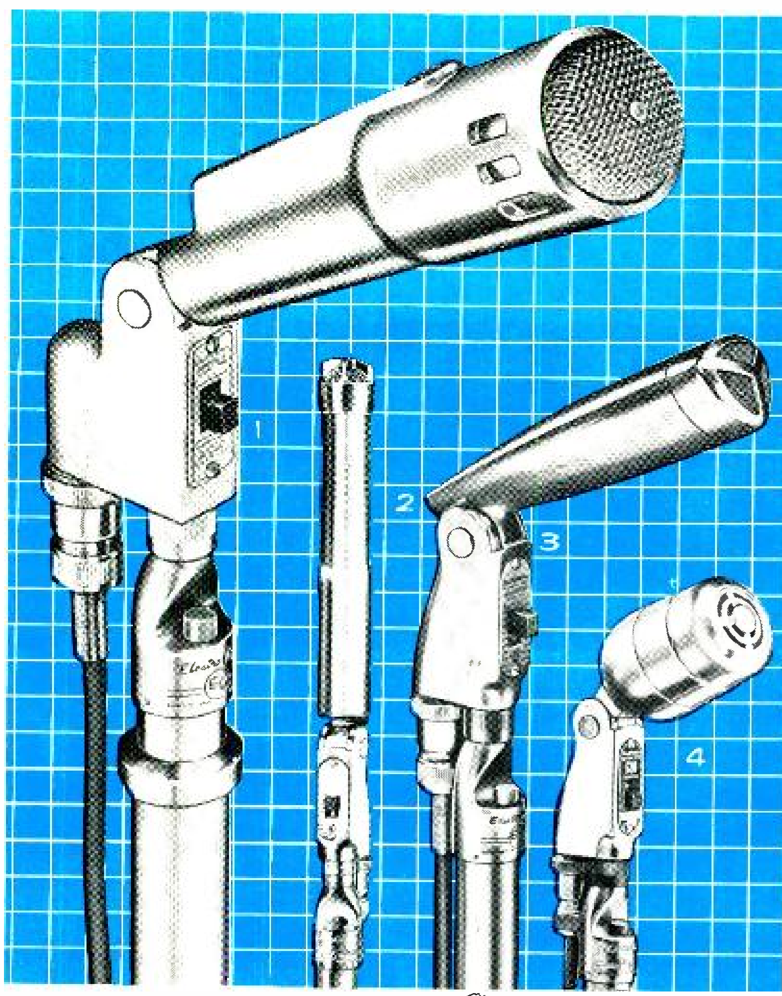

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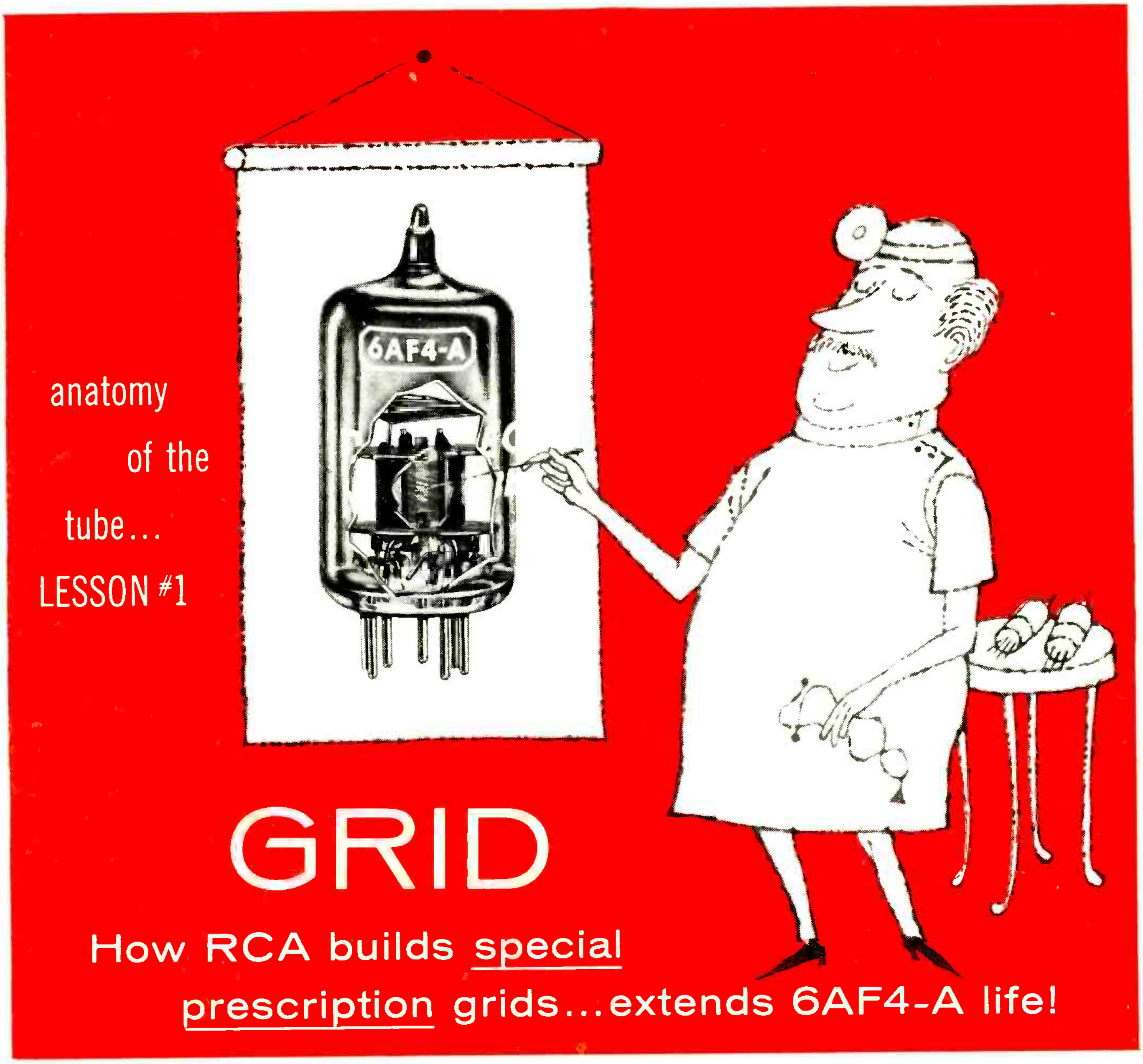

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